(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE

140 NASSAU STREET, NEW YORK

J. S. BONSALL, Business Manager.
F. H. THOMPSON, Eastern Representative

R. V. WRIGHT, E. A. AVERILL, } Editors.

OCTOBER, 1909

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Cincinnati. As was clearly shown by Prof. Hermann Schneider, of the University of Cincinnati, in a paper † presented before a recent meeting of the American Institute of Electrical Engineers, it is practically impossible to teach the trades in trade schools, because of the large number of young people to be trained and the great diversity of interests for which they must be prepared. Prof. Schneider's idea is that the problem will have to be solved by taking the school to the boy at his job, or, in other words, by devising a scheme of co-operation between the schools and the shops whereby the boy who is already employed will be made more efficient by mental training. This is exactly what the Cincinnati continuation schools are doing. When it came to the proposition of training five hundred or more apprentices in the machine shops, the question was merely one of detail, namely, how to take the public schools to these five hundred apprentices. The boys are sent to school one-half day per week for four years. They are rotated in such a way that the school has always the same number of students; that is to say,—a certain manufacturing company has six apprentices; one apprentice will go to school on Monday morning, the second one on Monday afternoon, the third one on Tuesday morning, the fourth on Tuesday afternoon, etc. About 250 apprentices are at present enrolled, and assuming ten half days of instruction per week, there will be twenty-five students at school every morning and every afternoon. The boys are paid for their time in school just as if they were working at their machines. Each half-day session has four hours of solid work.

Criticism may be made on the basis that the one-half day per week for four years is not very much schooling. If you consider, however, that the average public school pupil has about four hours of instruction per day, five days per week, you will see that this school gives to the boy already at work, almost one extra year of schooling. Furthermore, the instruction is such as to make him more efficient at his daily work and will also give him some fundamental training in good citizenship.

The half day per week arrangement is purely experimental and if it is found that it does not solve the problem, a re-arrangement will be made, holding, however, to the fundamental idea that the boy must receive his practical training in the shop, and his mental training in the public schools, under selected teachers.

While the present school is contemplated for machinist apprentices, it is expected to broaden it to cover all the industrial and commercial interests of the city. The details, of course, are not to be the same for the school of a department store, as for the machinist apprentices. In the department store the school will operate every morning *in the store* from eight to ten o'clock, when all the clerks are not needed for the work of the store. Each particular trade will be studied to find the most feasible means of obtaining training for efficiency, and in all cases the school will be taken to the boy who is on the job. A committee of manufacturers meet with a committee of the school board and the superintendent of schools, when necessity arises, to discuss and settle any questions which may come up.

COUNTERBALANCING LOCOMOTIVES.

Probably no American railroad officer is able to speak on the subject of locomotive counterbalance with greater authority than Mr. Vaughan. Readers who recall his paper on that subject before the North-West Railway Club fifteen or sixteen years ago will remember that it was far in advance of anything written on the subject up to that time.

The paper presented by him before the Canadian Railway Club last month is therefore of unusual interest since it not only measures the progress in our knowledge of this matter since 1893, but it directs attention to the valuable contributions made by such men as G. R. Henderson and R. A. Parke toward the solution of this problem. Mr. Vaughan's conclusions, as embodied in the practice on the Canadian Pacific and the experiments that are being made on that road, cannot fail to be of value to those interested in this subject.

APPRENTICESHIP.

Those who prophesied a few years ago that the new apprenticeship system that was being established on the New York Central Lines would deteriorate and die a natural death as soon as the first excitement passed off must be glad to learn that they were badly mistaken, and that after more than three years those who have followed its progress closely are more than ever convinced of the correctness of the principles upon which it is established. Many serious problems have arisen which could not have been foreseen, but these have been patiently and gradually solved; there is still much to be accomplished and in order to direct certain tendencies it is possible that some changes in the methods of instruction may be necessary, but these are largely questions of detail and may easily be solved as soon as the need becomes apparent. That any weakness will not remain long undiscovered is evident when one becomes acquainted with the instructors and those in charge of the department, and also the fact that the motive power department officers over the entire system are watching the progress of the work keenly.

A most important factor in its success is the loyalty and the interest that has been shown by both the drawing and the shop instructors. When it is remembered that these men were not specially trained for the work, but were selected from the various shop organizations, their success seems remarkable. With a very few exceptions it has not been found necessary to make changes from those originally selected. It simply demonstrates the fact that usually it is not only not necessary, but is foolish to go outside of an organization to find men for carrying on a special work. The trouble is not that there are not men capable of doing the work, but rather that those in charge are not big enough to find and direct them.

* * * * * * * * *

A number of the smaller roads are holding back in the matter of installing an up-to-date apprenticeship system, along the lines recommended in the report before the Master Mechanics' Association two years ago, because they do not see how it can be applied to a small shop, or a small road. If a road has several small shops it would seem that it could afford to have a man look after the drawing and mathematical end of the work, arranging the necessary courses and seeing that they are adapted to the men on the road in question. The drawing and problem work could easily be handled by this man, who could make regular trips to the shops and hold classes, or he could secure, and direct by correspondence and occasional visits, some one at each shop to give a few hours to it each week. If a road is small and feels that it can not employ a man as drawing instructor to arrange the courses and direct the work, why not combine with other roads in the same district and have some one at each shop give a short time to seeing that the drawing and problem work as laid out is taught?

As concerns the shop instructor, who is a most important and necessary factor in the system, it may be said that in a small shop with only a few apprentices it is not necessary for a man to give his entire time to this work. For instance, at the Jackson shops of the Michigan Central, Mr. Phelan, the shop instructor, for quite a period during the early development of the work gave only a portion of his time to it, and was regularly employed in operating a large planer. At the McKees Rocks shops, of the Pittsburgh & Lake Erie Railroad, the work for a considerable time and until recently was looked after by the assistant machine shop foreman.

* * * * * * * * *

It was not the purpose of the editors to make this issue an educational number, but the fact could not be overlooked that the first week in September marked the establishment of the educational bureau on the Union Pacific, the opening of the continuation schools at Cincinnati and the holding of the third annual conference of the New York Central Lines apprentice instructors. The remainder of the abstract of the instructors' conference will appear in the November number.

LOCOMOTIVES DESIGNED AND BUILT AT THE HORWICH SHOPS*

LANCASHIRE AND YORKSHIRE RAILWAY.

GEORGE HUGHES.†

[This excellent paper by Mr. Hughes is altogether too extensive to be completely reprinted in these columns and there is given below only a few extracts of possibly the most valuable and interesting of his observations to an American reader. The paper opens with a brief description with illustrations of the different steps in the locomotive development on this road from 1889, and clearly shows the excellent work of Mr. Aspinall now being ably continued by Mr. Hughes. Following this general section, a number of the more important details are considered, and it is from this section and the appendices that the following extracts have been chosen.—ED.]

Boilers.—In the first boilers with round top fire-boxes, experience proved that the tubes were placed too near the bottom and sides of the barrels, as pitting soon developed, especially in the neighborhood of the smoke-box tube-plate. Subsequent boilers were built with a fewer number of tubes, so as to give greater distance between the tube and barrel, and more recently the distance between the tubes has been increased from 9/16-inch to 11/16-inch. In 1896 the Belpaire type of fire-box was introduced into a number of shunting tank-engines. This type of box had advantages in the way of increased steam and water-space, additional surface on the back plate for mountings, and direct staying of the crown. A similar design, of suitable proportions, was adopted for the large engines. With these boilers it was impossible to introduce the inside box from the bottom, and Mr. Aspinall decided to pass it in from the back, and flange the back plate outward, for convenience of riveting up by machine. This method of flanging cured more than one evil, but resulted in setting up severe stresses in the crown-shell along the line of rivet-holes which join the back plate to the wrapper. There has also been much grooving down each side of the plate along the waist. To relieve the crown-plate of these stresses some engines have been fitted with a row of flexible stays at the back end. The later boilers are now being made with the back plate flanged inwards, the final operation of riveting up this plate to the wrapper being done by hand. All new fire-boxes of the larger classes since January, 1904, have had wider water-spaces, which have resulted in increased mileage and fewer repairs, particularly in the renewal of stays. The reduction of grate surface, caused by increasing the spaces, has not interfered with the steaming qualities of the engines.

In the 10-wheeled passenger and coal engines the original boilers had 239 tubes, 2 inches diameter, and the more recent boilers with wide water-spaces have only 225 tubes. In each top corner, a group of tubes, 15 in number, are reduced in diameter at the fire-box end to minimize the fracturing between the tube-holes at these corners.

Copper and steel tubes are used, and their life, as in the case of boilers, is influenced by several circumstances, but over a period of 8 years the average mileage works out as under:—

Copper, 1st period	(new)	110,000	miles.
" 2nd "	(stretched)	80,000	"
" 3rd "	(pieced)	50,000	"
Total		240,000	"

and subsequently 30 to 40 per cent. of those pieced are treated so again.

No. of Boilers cut up.	Average Age.	Maximum Age.	Miles.		Remarks.
			Average.	Maximum.	
336	18	38	485,480	1,207,191	For 10½ years ending December, 1897.
181	11¾	30½	326,187	739,798	27 months ending May 1902, and personally examined by the author.
206	14¾	29¾	356.268	959,944	For 3 years ending December, 1908.

Steel, 1st period	(new)	70,000 to 80,000	miles.
" 2nd "	(pieced)	30,000 to 40,000	"

Life of Boilers.—It is difficult to make just comparisons. This factor is influenced by many contingencies, such as pressure, constant employment, severity of use, etc. The table at the foot of the first column may be of interest.

Boiler Pressure:—

Previous to year 1888 the Boiler Pressures did not exceed 140 lb. per sq. in.
" " 1899 " " " " 160 " "
" " 1901 " " " " 175 " "
Present practice 180 lb. per sq. in.

Copper fire-boxes run from 150,000 to 275,000 miles, and copper tube-plates last 3¾ to 7 years.

In all cases the life of the boiler is dependent upon the amount of patching and renewals of wrapper and mouthpiece plates, and restoring of tube, throat, and barrel plates.

Life of Cylinders.—Over a period of 20 years it is found that the life of cylinders varies from 8 to 14 years. If they escape accident their life is dependent upon the wear of the valve faces.

The following table gives the average results of chemical analysis of cylinder metal:

Chemical Analysis:—

	Per cent.
Combined Carbon	0.3
Graphitic Carbon	3.0 to 3.5
Silicon	1.25 to 1.6
Sulphur	Under 0.10
Phosphorus	" 1.0
Manganese	" 0.8

In regard to the tensile tests, sometimes these reach 14 tons per square inch, but generally, good cylinder-metal would be about 12 tons per square inch. Transverse tests are taken on bars 3 feet between centers, 2 inches deep and 1 inch wide, and give 28 cwt. before fracture.

Crank-Axles.—The crank-axles used on all engines built by this company up to 1901 were of the solid type without hoops. The material was Siemens-Martin open hearth steel, having an ultimate tensile breaking load of 28 to 32 tons, with an elongation of 25 per cent. on three inches, and the usual bend test. Nearly all the flaws on these axles occurred on the inside of the connecting-rod journal at the bottom of the radius, where it joins the crank-web, due to the constant opening and closing of the throws. The following diagram, Figs. 91, 92, and 93, and table below give the position and percentage of flaws:—

These axles did very good service, averaging 250,000 miles

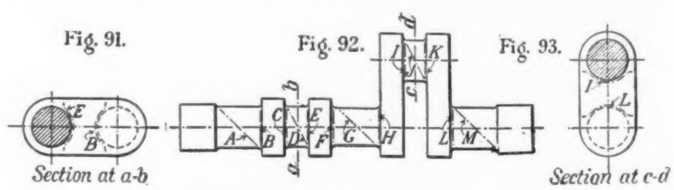


Diagram of Position of Flaws and Table of Percentage of Failures of Solid Crank Axles, from 1892 to 1909.

Class of Engine	A	B	C	D	E	F	G	H	I	J	K	L	M	Average Mileage
Standard Goods, Wheels 5-1 dia., Cylinders 17½ × 26.		6	6		27	12	3	6	21		3	15		243,932
Standard Goods; Wheels 5-1 dia., Cylinders 18 × 26.		9	9		14	15	2	11	31		3	3		232,932
Radial Tanks, Wheels 5-8 dia., Cylinders 17½ × 26.	2	5	9		18	20	3	13	15	2	5	4	2	285,674
Radial Tanks, Wheels 5-8 dia., Cylinders 18 × 26.		11	5		33	17	3	5	17			3		276,932
Bogie, Passengers, Wheels 7-3 dia., Cylinders 18 × 26.		15	16		20	16	3	10	10		3	4		247,031

* From a paper presented before the Institution of Mechanical Engineers at the July meeting.

† Chief Mechanical Engineer, L. & Y. Ry.

before being condemned. Having passed this mileage, axles frequently attain a life of 600,000 to 700,000 miles. Standardization and interchangeability caused the same type to be introduced in the design of the 10-wheeled bogie passenger-engines, the 10-wheeled radial tank-engines, and the 8-wheeled coal-engines, but the larger diameter cylinders, increased boiler pressures, demand for higher speeds and heavier hauling capacity, soon proved that this axle was inadequate to meet the stress; the built-up pattern therefore was introduced in 1901, having the same dimensions in the bearings as the solid type. This type has now been adopted as the standard practice of the Lancashire and Yorkshire Company.

The author thinks it will be interesting to give his experience in detail in regard to the design and manufacture of built-up cranks; it may save some useless experimenting by members and others. The first design, Fig. 88, was made entirely of mild steel, solid crank quality; the sweeps were made of figure 8 shape shrunk on the connecting-rod journals, bearings, and middle part, being further secured to the middle part and end portions by keys (1½ inch by 1 inch), rectangular section, and to the connecting-rod journals by screwed plugs (1½ inch diameter, 6 threads per inch). The shrinkage allowance was 0.009 inch, and the diameter of the holes in the webs 8⅝ inches. In a considerable number of cases the results were not satisfactory, as the tensile strength of the webs was unequal to the strains placed upon them, and consequently they worked loose. At the end of 1903 it was decided to make the crank webs of 0.35 carbon steel, and straight, instead of the figure 8 shape. The shrinkage was altered to 0.014 inch, and the holes in the webs reduced to 8¼ inches, thus giving a greater strength to the webs round the crank-pin, Fig. 89. These changes effected a decided improvement in one respect, as there was a considerable reduction in the number of cranks working loose at the webs. But a new difficulty developed: fractures were found commencing at the keyways, and in several cases they had extended a considerable length before being noticed. The first attempt to prevent these fractures, towards the end of 1904, was to increase the radius at the center of the axle from ¾ inch to 4½ inches, and also to put a small radius at the bottom of the key-bed, the result being that there were no more fractures in the center; but as it was not thought advisable to reduce the surface of the center bearing by extending the radius, the trouble was still likely to occur at that particular part. The only solution appeared to be the total elimination of the rectangular section keys. The first built-up crank-axle secured entirely with screwed plugs was made in March, 1905, and at the same time the shrinkage was increased to 0.018 inch. A short time previous to this change taking place, a series of tests, to determine the tensile limits of the crank-webs, was commenced; several webs were prepared with special pieces having a shrinkage allowance of from 0.010 inch to 0.016 inch. They were afterwards removed and records taken, which demonstrated that the shop practice of allowing 0.016 inch was well within the tensile limits of the webs. The next test, taken in October, 1905, was an attempt to fracture the webs by an absurdly high shrinkage allowance. The webs prepared had a shrinkage of 0.030 inch and 0.040 inch, and after being shrunk together, the one with 0.040 inch was drilled and tapped at the usual position. A special plug was driven in with extreme pressure and the web struck with a large hammer. As no fracture occurred, the plug was withdrawn, and the pieces pressed out. The records taken proved that the elastic limit of the webs had now been exceeded, as the webs with 0.030 inch allowance required 318 tons each to move the pieces, and those with 0.040 inch allowance took 298 tons. 230 cranks have been built by the present method, and sent into service, and of these only two have been condemned. Briefly, it may be stated that the mild-steel cranks were succeeded by those made of 0.35 carbon-steel, the shape being altered from figure 8 shape to straight webs. Cranks with screwed plugs were introduced in March, 1905. The shrinkage has increased from 0.009 inch to 0.018 inch, and the diameter of the hole in the standard crank-webs reduced from 8⅝ inches to 8¼ inches. This shrinkage amounts to 1/458 part of the diameter. The author does not propose to give the life of condemned built-up cranks during the experimental stage, but the subjoined table shows the average and maximum mileage of these cranks in use on the heavier and more powerful engines at the present time.

Class of Engine	Diam. of Cylinders	Diam. of Wheels	Boiler Press.	7½-in. diam. Journal.		8-in. diam. Journal.	
				Average.	Maximum.	Average.	Maximum.
	in.	ft. in.	lb.				
10-wheeled bogie .	19	7 3	180	—	—	96,400	142,947
10-wheeled radial tank .	19	5 8	180	106,568	117,736	—	—
4 ft. 6 in. coal engine .	20	4 6	180	86,780	98,750	—	—

MILEAGE OF CRANK AXLES ON HEAVY POWER.

The heavier loads upon the axle-box journals of the 4-cylinder passenger-engine have necessitated the adoption of a stronger crank-axle, but the same method of manufacture has been adhered to. The webs, Fig. 90, are extended to form balance-weights. Heating of journals or crank-pins must be specially avoided in built-up cranks.

Wear of Cranks.—The axle-box journals wear oval at right angles to the near web. This wear has never been found to exceed 1/32 inch, and is not always on the same side. They also sometimes wear taper, but this is rare, and not allowed to exceed 1/16 inch. Connecting-rod journals also wear oval, but never more than 1/64 inch.

Renewal of Tires.—In the case of wheels up to 5 feet 8 inches diameter, providing the tires will turn up to 1½-inch thickness

Fig. 88

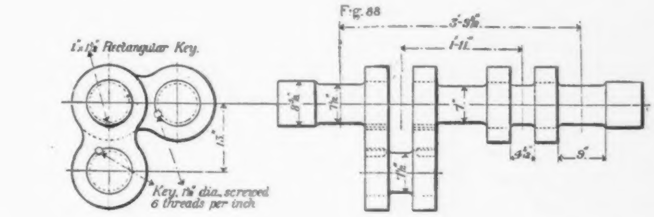


Fig. 89.

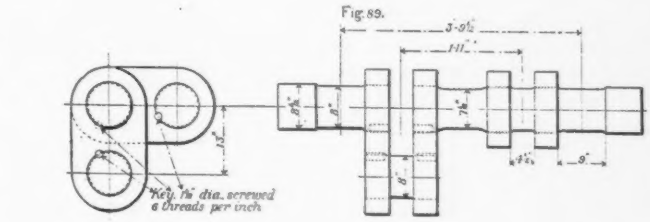
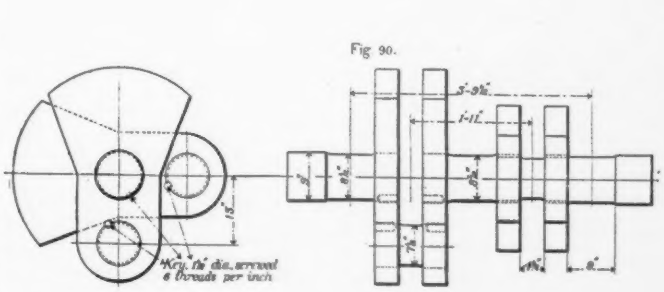


Fig. 90.



and are in sound condition, they are retained. For wheels over this diameter the limit is 1¾ inches. For the half-year ending the 31st of December, 1908, out of 917 scrapped tires, 674, or

73½ per cent., were worn to the limit; 123, or 13 per cent., scrapped on account of slackness; and 8 or 9 per cent. for thin flanges; the remainder for flaws, blow-holes, or wheel defects. Some three or four years ago, with wheels of the larger diameter, the minimum tire thickness allowed had to be increased, because a considerable number of large tires showed signs of slackness, thereby increasing liability to fracture, hence the 1¾-inch minimum. At that time, tire material was generally 38 to 42 tons tensile, which has gradually been raised from 42 to 48. This hardening of the material, and in some cases strengthening of the rims, where new centers have been supplied, has been the chief step taken to prevent tires becoming slack. In the 10-wheeled bogie passenger class, which has the largest proportion of slack tires, the main cause of this tendency must be attributed to the comparatively weak wheel-center.

Practice Regarding Shrinking.—Previous to November, 1908, the practice with regard to shrinkage was not quite proportionate to the diameter. Too much shrinkage was allowed in the case of small tires, and probably not enough with large tires. After some consideration, the shrinkage was revised and now stands at 1/750th of the wheel center diameter for all sizes.

Smoke-Boxes, Brick Arches, and Ashpans.—The success of an engine entirely depends upon the boiler, and the excellence of the latter turns on these subjects.

The primary function of the smoke-box and its equipment is the production of draught, to economically burn the fuel at a proper rate, and at the same time, to maintain satisfactory steaming when working under all conditions of service. These qualifications are dependent largely upon proper proportions; the location and diameter of blast-pipe nozzle; its relation to chimney and tubes, and height and diameter of chimney. Blast pipes require to have an orifice sufficiently large to prevent back pressure in cylinders, and at the same time small enough to produce efficient draught. A proper disposition of the blast-pipe orifice, in its relation vertically to the chimney top, together with its right height from the boiler center line and a correctly proportioned chimney, will enable the orifice to be increased in diameter.

It must be remembered that an enormous amount of air enters the fire-box, and is immediately expanded six to eight times by rise of temperature, and upon arrival at the smoke-box and exit from the chimney, it is two or three times its original volume; and as the office of the smoke-box equipment is to deal effectually with this air, which is a variable quantity, a combination must be discovered for each class of engine, which will produce the best all-round efficiency. With a view of arriving at some conclusions on this question, the author has from time to time carried out experiments on certain classes of engines, with the following results:—

Long versus Short Smoke-Boxes.—To ascertain the value of long and short smoke-boxes observations were taken on two passenger tank engines. Particulars are given in table 9.

TABLE 9.

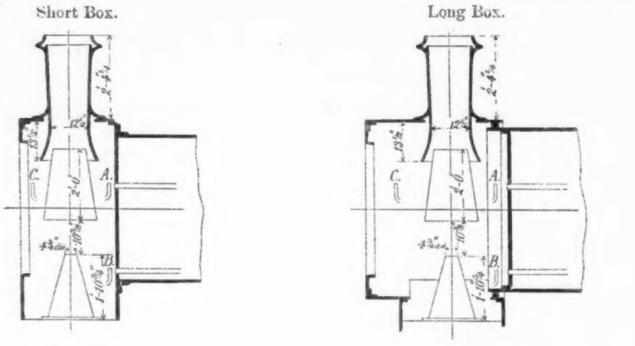
Length of smoke-box.	Cubical Capacity of smoke-box.	No. of tubes.	Length between tube-plates.	Area through tubes.	Grate area.	Air-space through grate.	Per cent. of air-space.	Area through ashpan door opening.
	cub. ins.			sq. ins.	sq. ft.	sq. in.		sq. in.
32⅛	100,190	220	11-0	388.7	18.75	865.25	32	274.95
46½	111,390	220	10-9⅜	388.7	18.75	919.6	34	215.87

Both engines were equipped with identically the same blast-pipe, chimney and hood, but the smoke-box of second engine had a capacity 11 per cent. greater than that of the first. The smoke-box arrangements of the two engines are shown by the following diagram.

Vacuum readings were observed at points A, B, C, through pipes projecting into the smoke-box to the vertical center line of the engine; the outer end of each pipe was connected by rubber tubing with one leg of a manometer, or "U"-shaped glass tube, partially filled with colored water, and the table underneath gives a summary of the results.

In perusing this table it will be noticed that the vacua are even, all over the tube-plate, indicating that the position of blast-nozzle, hood, and chimney, appeared to be about right.

Short Box. Long Box.



Test / Type of Smoke Box.	Between Manchester and Bolton. Vacuum in Inches Water Gauge. Top row of Tubes. A	Bottom row of Tubes. B	In front of Blast Pipe. C	Boiler Pressure, lbs. per sq. inch.	Cut-off, per cent. of Stroke.	Between Bolton and Entwistle. Vacuum in Inches Water Gauge. Top row of Tubes. A	Bottom row of Tubes. B	In front of Blast Pipe. C	Boiler Pressure, lbs. per sq. inch.	Cut-off, per cent. of Stroke.
Short Type.	3"	3"	3"	157	39.2	3"	3"	3"	157	39.2
Long Type.	3"	3"	4"	175	50.2	4.4"	4.4"	5.2"	174	51.7

With the extended smoke-box, a higher vacuum is recorded at C than at A and B, which tends to prove that the long box serves as a reservoir, thus assisting the maintenance of draught between each exhaust, and so modifying the intermittent character of the blast. This is verified by the action in the glass tubes. With the extended smoke-box the water remains quite steady, and only moves when the steam discharge up the chimney is altered; whereas with the short box the water is in a constant state of agitation, rising and falling with each exhaust. The vacuum in both smoke-boxes was about normal for the cut-offs of 39 and 51 per cent. respectively, but steam pressure was better maintained in the extended smoke-box engine.

A series of experiments were conducted on one of the passenger tank engines with extended smoke-box. Five different arrangements were tested as follows:—

A. Blast pipe 1′ 2¼″ below horizontal center line of boiler; hood 1′ 11½″ long.
B. Blast pipe 1′ 2¼″ below horizontal center line of boiler; hood 1′ 5½″ long.
C. Blast pipe 1′ 2¼″ below horizontal center line of boiler; without hood.
D. Blast pipe 0′ 2¼″ below horizontal center line of boiler; without hood.
E. Blast pipe 0′ 9¼″ below horizontal center line of boiler; hood 1′ 5½″ long.

On the first four tests the loads were the same, namely, 160 tons behind the drawbar, but on test E the train hauled was 200 tons. The same chimney was used on all trials, namely, 12½ inches diameter choke, tapered, and increasing 1.4 inch per foot towards the top, length 2 feet 4¼ inches. The blast-nozzle was 4¾ inches diameter in all cases. The following table gives the summary of results. The best conditions were obtained from test E arrangement, as regards the highest vacuum, and least

Summary of Results.

Test	Average Speed, miles per hour.	Average Cut-Off, per cent. of stroke.	Average Steam Press, lbs. per sq. inch.	Average Vacuum - Inches, Water Gauge. Readings taken at top row of Tubes.	Readings taken at bottom row of Tubes.
A	34.4	36.2	168.5	2.3"	3.5"
B.	37.6	31.37	175.4	2.75"	3.75"
C	38.4	26.6	176.5	1.66"	3.166"
D.	40.2	36.2	164.6	2.5"	3.5"
E.	38.6	30.1	174.3	3.875"	4.375"

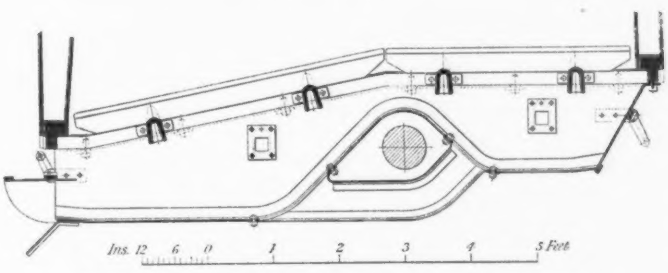
RESULTS OF TESTS ON FRONT ENDS.

variation in the intensity of draught at the top and bottom row of tubes. Test C was also very satisfactory, considering the low vacuum maintained. This, however, is accounted for by the fact of the weather being calm on that occasion, enabling the engine to be operated at an earlier cut-off, and with less demand on the boiler.

Results of Experiments on 4-Cylinder Passenger Engine.—This engine when first put into service had a 5-inch diameter blast-nozzle standing 8 inches below the center line of boiler. The chimney was only 12½ inches diameter at the choke, and had an extension in the smoke-box of 15 inches. This extension carried a hood 1 foot 6 inches long. Further particulars are given below:—

Length of smoke-box	68 in.
Capacity of smoke-box	249,000 cu. in.
Number of tubes	235
Length of tubes	15 ft.
Area through tubes	564.0 sq. in.
Grate area	27.0 sq. ft.
Air-space through grate	9.47 sq. ft.
Percentage of air-space	35
Area through ashpan, door open	394.0 sq. in.
Minimum area of ashpan opening	63.0 sq. in.

On the first trial it was evident that the nozzle was too small, and it was decided to open it out to 5½ inches. This step, however, at first had a detrimental effect on the steaming, until the author tried a chimney of a different design. He retained the same pattern, but cut down the extension portion, to penetrate into the smoke-box 2 inches only, which increased the choke to 13½ inches diameter. He also belled out the entrance to 18 inches diameter. It was apparent at once that this form of chimney, although not quite satisfactory, improved the steaming; therefore further investigations were conducted on the best height of nozzle, and eventually it was found to be about 4 inches below center line of boiler. During these experiments, complaints were frequent that the fire burnt dead at the back end of the fire-box, and conclusions were drawn that this was due to the restricted air-space opening in the ashpan, where it is narrowed down in depth to clear the trailing axle. The author next decided to give additional air-supply to the back end of grate. He therefore connected the front and back portions of the ashpan by an air-duct shown in the accompanying illustration.



ASHPAN FOR FOUR-CYLINDER PASSENGER LOCOMOTIVES.

This addition increased the air-supply opening over 300 per cent., and has proved very beneficial in promoting combustion.

A further experiment has recently been made with a larger blast-pipe and chimney. The blast-pipe is cast with a bridge, so that the exhaust from the inside and outside cylinders is led away independently, and does not meet until near the top of the nozzle. The nozzle is 6 inches diameter, and the chimney choke 16 inches, the same design of chimney with short extension being adhered to. At first this combination was not successful, but after several trials with varied heights of blast-pipes, a position was discovered (viz., 6 inches below center line of boiler) which produce an excellent steaming engine.

These experiments go to prove the importance of ascertaining the correct positions and proportions of blast-pipes and chimneys; for here is a case of an engine which would not steam with a 5½-inch blast-pipe, but which eventually, after numerous experiments, steamed well with a 6-inch nozzle. Attempts have been made in America to standardize front ends, with some amount of success; but it appears to the author that each new design of locomotive demands some experimental work, in order to arrive at the best steaming position of blast-pipe, diameter of chimney, etc.

Smoke-Box Doors.—These are much larger than ten years ago. They cannot be kept perfectly tight by the single crossbar and central bolt arrangement, and a number of dogs pitched equally round the periphery of the door is essential. The wear and tear of smoke-boxes has increased of late years, particularly that class with the sides fastened to the main frames of the engine. The round smoke-box, supported on a cast-iron saddle, has much to recommend it. The author has adopted this design on several tank engines, and also on the 4-cylinder passenger engine. This latter smoke-box has been clothed with asbestos and a thin clothing sheet, for the purpose of reducing cost of maintenance.

Brick Arches.—All engines are fitted with brick arches. These extend from the tube-plate to about half the length of the fire-box. The rake of the arch is governed to some extent by the position of the fire-hole above the grate. When this distance is small and the fire-box long it is necessary to incline the arch, so that there is no chance of throwing the fuel upon it. With the fire-boxes which have horizontal grates the arch slopes upwards, pointing to the top side of the fire-hole. In the 4-cylinder engine the slope points to the top corner of the back plate. The function of the arch is to assist combustion by maintaining a high temperature, and to direct the gases round the fire-box, especially so that they impinge against the top and back plates. The fire-hole deflector is used to prevent the air passing direct to the tubes.

Ashpans.—All ashpans are made of ample dimensions, so that the accumulated ashes do not hinder air-supply. The damper doors open as wide as possible to allow a maximum air-supply, and for convenience of raking. The bottom is made to retain water for quenching the ashes, a small pipe being connected to the injector feed-pipe, and led to the ashpan for that purpose. The damper door-handles are fixed on the fireman's side of the engine, and have a screw arrangement for adjusting the amount of air, and for closing the door practically air-tight.

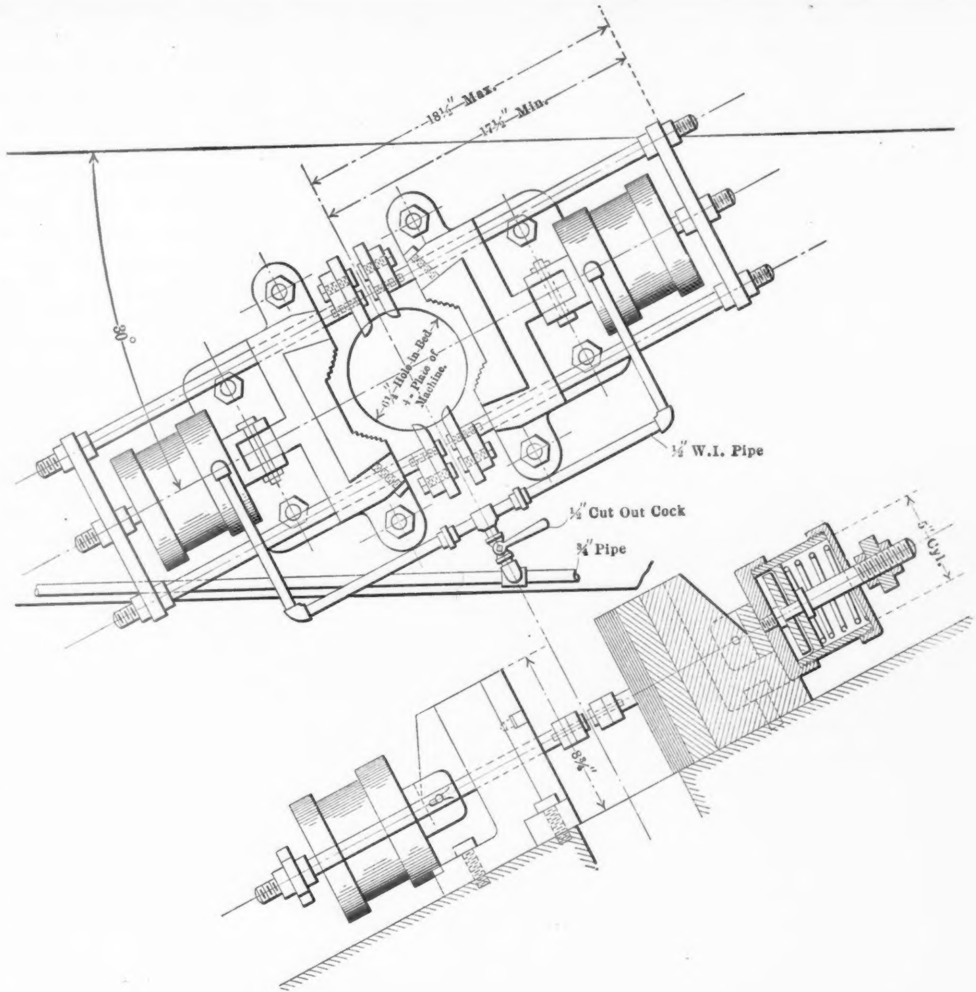
SMOKE PREVENTION IN LOCOMOTIVE OPERATION.—It has been well said, "The man behind the scoop, when properly educated, is the most efficient fuel saver and smoke arrester in existence," and this is true of the operating conditions of every locomotive on every railroad burning soft coal. The matter lies largely in the hands of the engineer and fireman, and the engineer as well as the fireman. Better results can be accomplished by the properly instructed and rightly-dispositioned crew, without any contrivance to prevent smoke, than can be obtained by the most elaborate mechanical provisions without the exercise of brains and interest by the men in the cab; and it is probable that the larger proportion of good results obtained, during tests of various devices to save fuel and prevent smoke, really result from the awakened interest and harmonious coöperation of the engineer and fireman. Fuel saving and smoke prevention on railroads is mostly a matter of *agitation* and *education*. One of these is as necessary as the other, but the best results follow the proper employment of both means of improvement.—*George H. Baker before the New England Railroad Club.*

GAS VERSUS STEAM ENGINES.—I am fully aware of the possibilities claimed for the gas engine, but my experience thus far, and the practical results with which I am conversant, do not indicate an early fulfilment of the claims. From present indications, the best steam and the best gas engine plants appear to be about on a par with regard to coal economy. The producer plant and the boiler plant are practically equal so far as the first step in converting the coal into power is concerned. The average gas engine is more efficient than the average steam engine, but the best gas engines and the best steam engines are about equally efficient.—*From President M. L. Holman's address before A. S. M. E.*

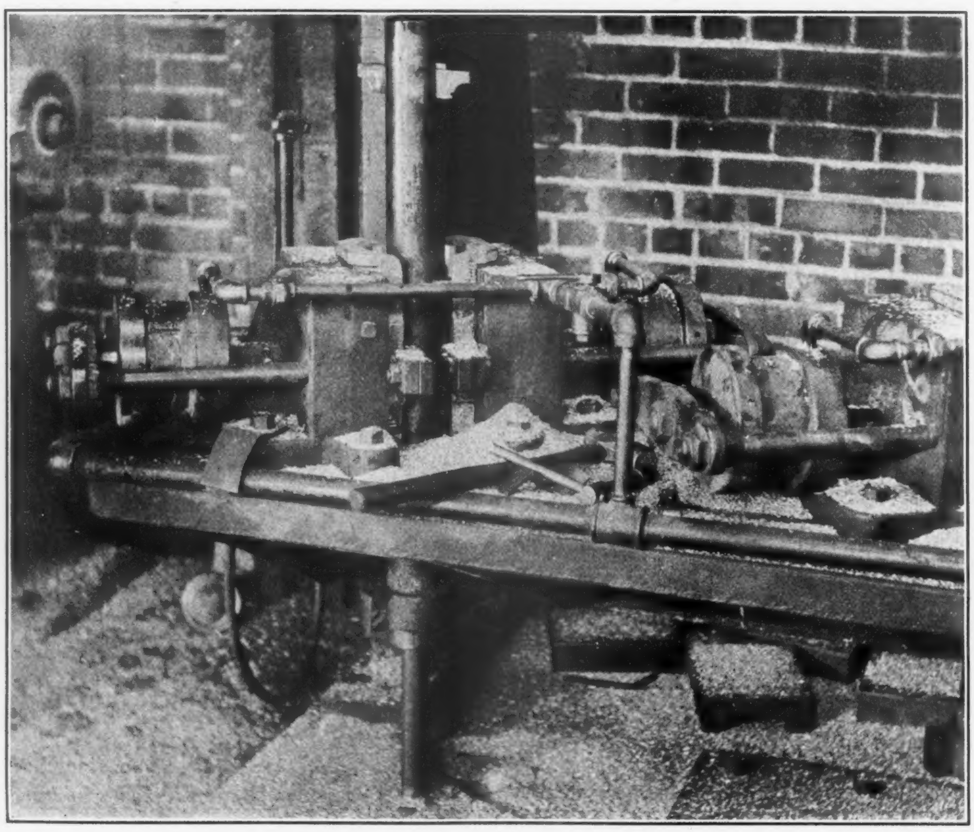
BORING CAR JOURNAL BEARINGS.

A four-spindle drill press has recently been converted into a machine for boring car journal bearings at the Collinwood shops of the Lake Shore & Michigan Southern Railway. A home-made chuck for each spindle clamps two bearings at one time. Each bearing is held in place in the chuck by two clamps which are fastened to the rods attached to the crosshead on the end of the air piston, clearly shown in the photograph. When air is applied back of the piston it forces the piston and crosshead outward, drawing the rods and clamps with it, bringing the bearing up tight against the seat in the chuck. Both cylinders for each spindle are controlled by one stop cock.

The boring bar has a hole in its lower end in which the rod guiding it fits. This arrangement prevents the chips from getting into the guide and cutting. A filleting tool is provided at the top of the bar. Each spindle has an independent motion and a cut-out so that when the boring tool has passed through the bearing the spindle is stopped independently of the others. This adjustment is so close that it may be arranged to stop the spindle after the fillet is properly completed. The operator is thus enabled to give his entire attention to the removing and replacing of the bearings without reference to the operating spindles. The machine has proven very successful.



AIR OPERATED CLAMPS FOR HOLDING JOURNAL BEARINGS.



ONE SPINDLE OF MACHINE FOR BORING JOURNAL BEARINGS.

LONG LOCOMOTIVE BOILER BARRELS.

[The following communication appeared in a recent issue of *The Engineer* (London).—Ed.]

SIR,—The saying that "necessity is the mother of invention" is clearly applicable to the 50-ft. long boiler of the new Mallet locomotive for the Southern Pacific Railway, shown on page 223 of your issue of August 27th, and the draughtsman who was confronted by the difficulty of finding thermal use for the immense length of barrel necessary for spanning so many axles, is to be congratulated upon his solution of the problem.

The point naturally arises as to how long a locomotive boiler barrel would have to be made in order to embrace a further series of questionable economies—what, indeed, is the limit of ingenuity, on the part of the draughtsman in vertically dividing up the surplus length to find jus-

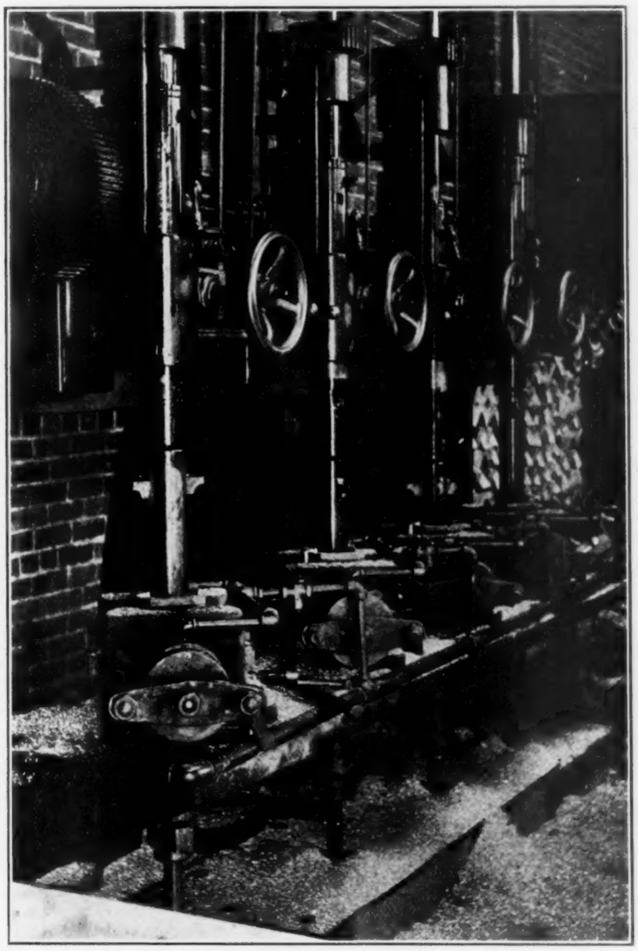
tification for the same beyond that called for by the locomotive design?

Having regard for recent discussion upon the economical length of the locomotive boiler tube, one could commence by cutting off the useless last 5 feet of the tubes in the boiler under notice, so as to increase the space available for sections of naturally diminishing temperatures suited to a variety of purposes.

Allowing, then, boiler tubes of 16 feet in length, we might allow—

For the combustion chamber	4 ft. 0 in.
For the feed-water heater	4 ft. 6 in.
For a sand drier	2 ft. 3 in.
For a food-warming compartment	2 ft. 0 in.
For a clothes-drying compartment	2 ft. 0 in.

There being little heat left for the superheater, this space could be utilized for other purposes; in fact, one may expect with still more immense locomotives of the Mallet system, that by the time the gases laboriously reach the smoke-box, the temperature may



MACHINE FOR BORING CAR JOURNAL BEARINGS.

be a minus quantity, thus enabling the last section to serve as a refrigerator for preserving perishable articles of food for use in the dining car on a long journey. Antiplea.

THE COST OF HIGH SPEED.

In commenting on the recent record run of the *Lusitania* when an average of 25.85 knots, or 29.75 miles, were made per hour, *Power* has this to say:

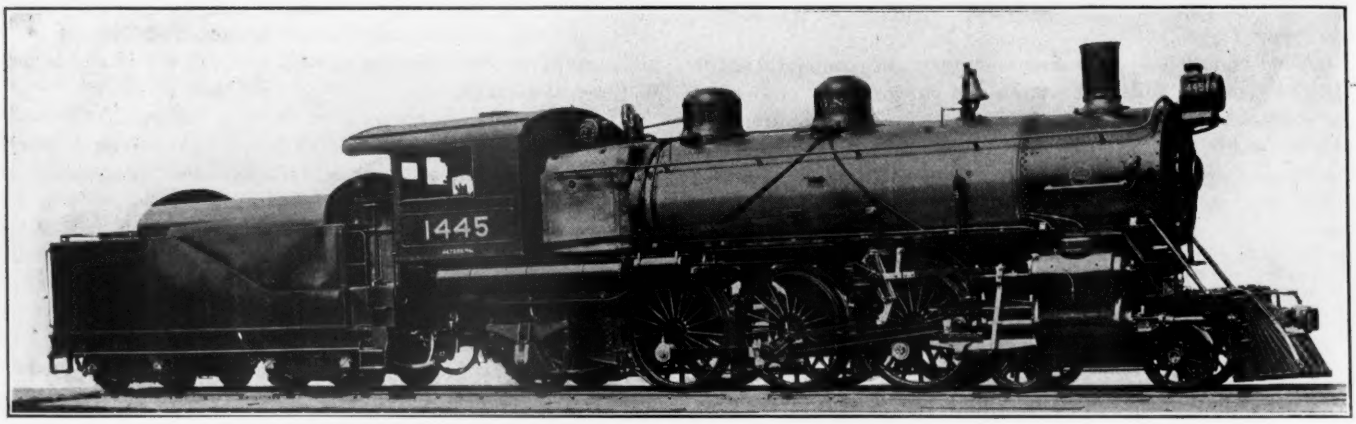
"To run a boat the size of the *Lusitania* at eighteen knots, or 20.7 miles, an hour, would require approximately 350 tons of coal a day. The time for a voyage would be six days and ten hours instead of four and one-half days, and the coal consumption 2,246 tons as compared to 4,725, and probably a much larger quantity when the coveted four days to complete the trip is a matter of history. The excess in speed already attained over the moderate figure of eighteen knots per hour costs nearly 2,500 tons of coal on each trip, or in other words, fuel enough to last five families throughout the natural lives of the household. This is but one trip and one vessel, and although no figures are available, a proportionate increase in railway speed would add largely to the coal consumption.

"It is, of course, apparent that the cost of provisions, labor, interest on investment, etc., will be less, and the greater charge for passage will in all probability make the faster boat and faster train paying investments, aside from the advertising the line receives. Four days to the other side or to the Pacific ocean from New York means much to men of business and is hailed with delight by the tourist, but when considered only from the standpoint of conservation of the fuel supply, high speed bears the ear marks of extravagant waste. More especially is this true when it is considered that the boat lays five days in port before starting on the return trip, and full advantage is not taken of the faster passage to reduce the number of ships in service. From the standpoint of the business man and advancement in the field of navigation, the question must be viewed in an entirely different light, and here the motto would, and should be, the faster the better."

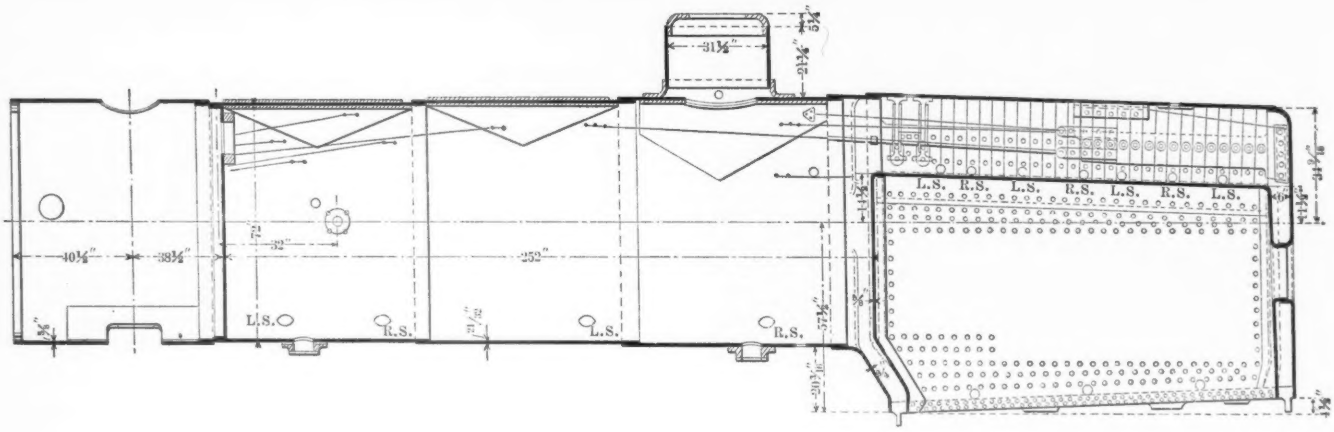
Economizers, Cost and Saving.—The unit costs of economizers and fixtures figure out as follows for machines of from 1,000 to 5,000 horse-power: Economizer, $2.75 per horse-power; brickwork, 60 cents; dampers, 2 cents; sectional covers, 13 cents; sheet iron, 8 cents; total, $3.58 per horse-power. A 5,000-horse-power economizer will figure complete about $18,000 and its saving may be estimated, with stack temperatures of 400 degrees and feed water at 200 degrees, as follows: Rise of feed temperature (70 degrees is the very best attainable), say 60 degrees. For each degree rise in feed water the evaporation gains 0.1 per cent., or 6 per cent. for 60 degrees. At 260 tons per day, 6 per cent. of the coal means 15 tons saved, which, at $3 per ton fired is $45 per day. As the actual boiler horse-power is seldom more than 75 per cent. of the total capacity of the boilers, however, the actual saving would be about $33. This amounts to $12,045 in a year and will pay for the economizer in about two years, allowing for all cleanings and repairs and maintenance charges. *—Warren H. Miller in Power and The Engineer.*

Patent Office.—Last year the patent office issued 33,514 patents, reissued 168 patents and registered 6029 trade-marks, labels and prints. There were 22,328 patents which expired during the year. The total receipts were $1,896,848 and the expenditures $1,712,303. On Jan. 1, 1909, the patent office had a balance to its credit with the United States treasury of $6,890,726. The work on that date was current, except in five examining divisions out of 49, and those five have caught up since then. Special attention is being directed to the classification of the 915,000 United States patents, the 2,000,000 foreign patents and the 85,000 volumes in the library, which is expected to reduce the expense of examining applications by one-third, and to improve the character of the work. Commissioner Moore has requested Congress to use a part of the surplus earned by the patent office for the erection of a building suitable for its needs.*—The Engineering Record.*

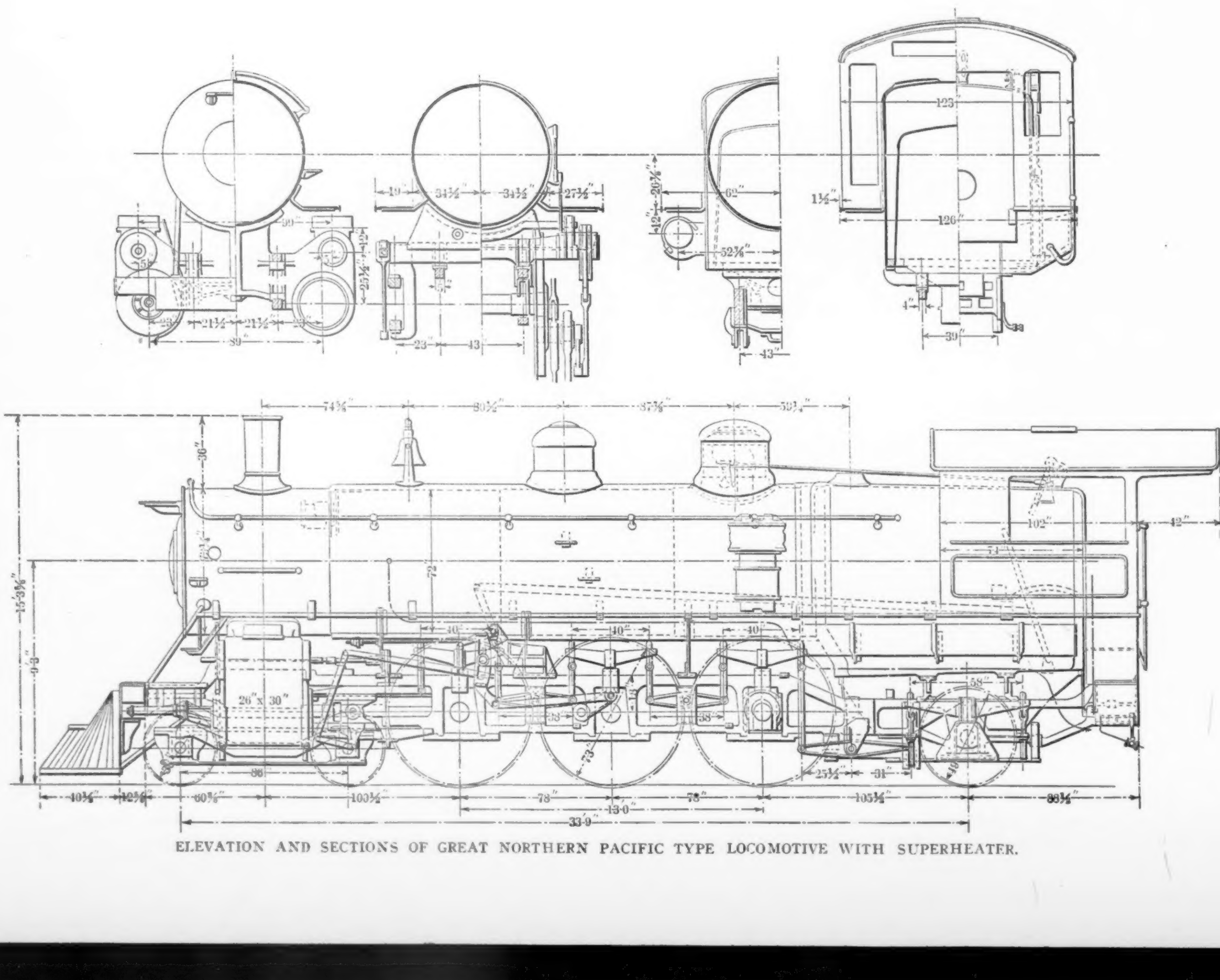
Practical Benefits of Standardization.—The practical benefits of standardization are apparent in many ways. The ability to order in large quantities standard articles, free from a capricious variety of details, makes possible a reduction ranging from perhaps 10 to 30 per cent. in the purchase price of many staple items of construction, maintenance and operation. Again, if a washout or other emergency occurs, a standard bridge, water tank, turntable, etc., can be ordered from the manufacturers in a ten-word telegram, and, pending delivery, a standard foundation can be built in full confidence that the structure will fit. Standard devices, signs, and equipment make it possible in emergencies to balance forces and resources by transferring men or material from one property to another with a minimum of inconvenience to the service and to individuals in orienting themselves to strange localities.*—J. Kruttschnitt, N. Y. R. R. Club.*



PACIFIC TYPE LOCOMOTIVE WITH SUPERHEATER—GREAT NORTHERN RAILWAY.



STRAIGHT TOP BOILER—GREAT NORTHERN RY. 4-6-2 TYPE LOCOMOTIVE.



ELEVATION AND SECTIONS OF GREAT NORTHERN PACIFIC TYPE LOCOMOTIVE WITH SUPERHEATER.

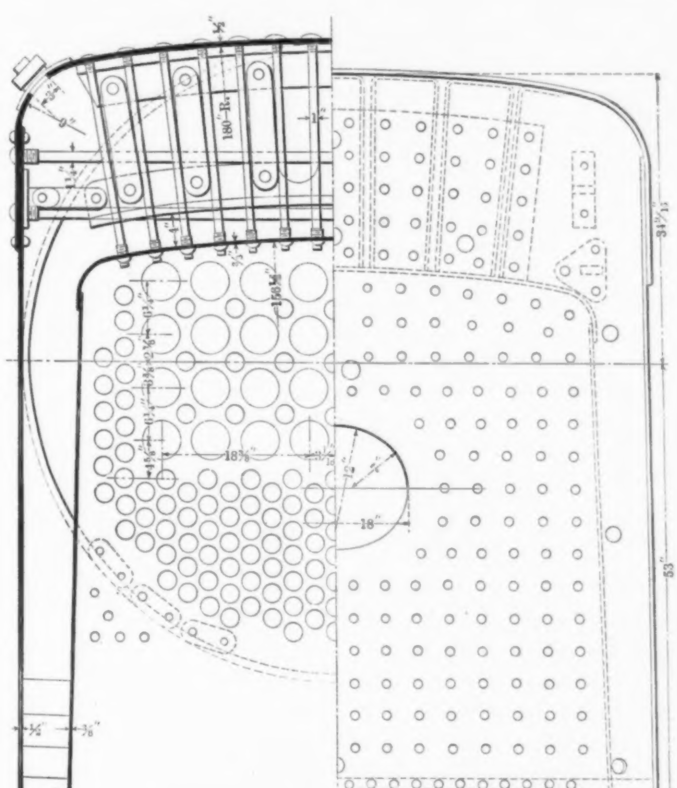
PACIFIC TYPE LOCOMOTIVE WITH SUPERHEATER.

Great Northern Railway.

Twenty locomotives of the 4-6-2 type, using high degree superheated steam at 150 lbs. pressure, have recently been completed by the Baldwin Locomotive Works for the Great Northern Railway.

These locomotives are among the heaviest and most powerful ever built and weigh 248,970 lbs. total, being exceeded in this regard only by the engines of this type on the New York Central Lines, which were illustrated on page 164 of the May, 1908, issue of this journal and the two on the Pennsylvania Lines, which were shown on page 267 of the July, 1907, issue. The Great Northern engines, however, are more powerful than either of these heavier examples, having a tractive effort of 35,400 lbs. as compared with 29,200 and 30,700 lbs. respectively. This is the largest tractive effort for a Pacific type locomotive on our records. The factor of adhesion, however, indicates that it will be capable of attainment without difficulty whenever needed.

This order of locomotives follows a series of experiments with a high degree of superheat on both this type and the Prairie type



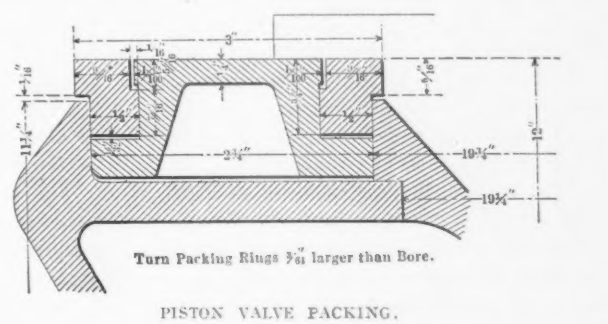
SECTION AND ELEVATION OF FIREBOX—PACIFIC TYPE LOCOMOTIVE.

passenger locomotives and hence indicates the successful service of low boiler pressure with high superheat for high speed passenger service. They have, however, shown themselves to be capable of very satisfactory performances in freight service as well, one of this order having recently hauled a train of 61 cars weighing 3050 tons, a distance of 98 miles in a net running time of five hours, the maximum grade being .6 per cent. for a distance of two miles, and the engine consuming seven tons of Illinois coal and two tanks of water.

In accordance with the general practice on the Great Northern Railway the boilers are of the Belpaire type and while a pressure of about 150 lbs. is used, they are designed for 210 lbs. pressure. The illustration shows the features of the boiler clearly and attention is directed to the staying of the back head, where plates are used which, in addition to being secured at the top to the roof sheet, are also secured to stays which run forward and fasten to the cylindrical part of the boiler shell, thus relieving the attachment of the roof sheet of a large part of its stress. The barrel is built up of three rings having butt seams on the top center line with diamond weld strips on the inside. Ample facilities have been provided for washing out, as a study of the boiler illustration will indicate. Wash out plugs are located quite close together on both sides of the fire box at the crown sheet and two 6-inch hand holes are located in the waist of the boiler in addition to the openings at the mud ring.

The superheater elements are contained in thirty-two 5½-inch boiler tubes. These tubes replace about 96 of the regular 2¼-inch tubes, but the total fire heating surface is reduced only about 220 square feet by this substitution. All tubes are 21 feet long and the superheater has a heating surface of 641 square feet.

Because of the reduced boiler pressure the cylinders are enlarged to 26 inches in diameter and are provided with walls sufficiently thick to enable them to be subsequently bored to 27 inches diameter if desired. The stroke is 30-inch. The pistons are of cast iron and provided with a front extension piston rod, which carries the greater weight of this part. The steam distribution is controlled by 12-inch piston valves, each valve being composed of a body casting with two heads, or followers, of the



PISTON VALVE PACKING.

usual type. The packing rings, a section of which is shown in one of the illustrations, are parted at the bottom and are carried in bull rings, which slip over the followers. The valve rod also has a front extension and the weight of the valve is carried by it, the bull rings being arranged to float on the followers. The valve setting is shown in the table at the end of this article. The by-pass valves are somewhat similar to those used on the Pennsylvania Railroad, the live steam ports being extended upward above the steam chest and the ports at that point being covered by a flat plate held down by steam pressure acting on its upper surface. This plate has a limited amount of rise and is guided by a central spindle and excess pressure within the cylinders will readily lift it from its seat. The steam chests are set out sufficiently to avoid the use of rockers in the valve gear and the width over the outside of the cylinders is 121 inches, making these the widest locomotives at this point of any passenger engines on our records. The links of the valve gear are supported on a cast steel bearer which spans the frames between the first and second pair of driving wheels and the valve rods are carried in brackets bolted to the guide yokes.

Cast steel frames, 5 in. in width, with separate rear sections of the same material, and double front rails of forged iron, were

specified in this design. The trailer truck is of the radial swing type with outside journals similar to the ones used on the Mikado type locomotives for the Virginian Railway, the details of which were illustrated on page 228 of the June issue of this year. The truck wheels under these engines are steel tired with cast steel spokes and the tender wheels have cast steel plate centers. Other cast steel details include driving boxes, crossheads, crosshead shoes, cylinder heads, equalizing beams and deck plates.

A novelty is noticed in the location of the throttle rigging. The valve is operated by a shaft which passes through a stuffing box in the side of the dome and carries an upwardly extending lever from the end of which a rod connects to the throttle lever in the cab, which swings in a vertical plane.

The general dimensions, weights and ratios of these locomotives are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Passenger
Fuel	Bit. Coal
Tractive effort	35,400 lbs.
Weight in working order	248,970 lbs.
Weight on drivers	165,220 lbs.
Weight on leading truck	39,900 lbs.
Weight on trailing truck	43,850 lbs.
Weight of engine and tender in working order	397,000 lbs.
Wheel base, driving	13 ft.
Wheel base, total	33 ft. 9 in.
Wheel base, engine and tender	66 ft. 4 in.

RATIOS.

Weight on drivers ÷ tractive effort	4.66
Total weight ÷ tractive effort	7.03
Tractive effort × diam. drivers ÷ heating surface	822.00
Total heating surface ÷ grate area	58.80
Firebox heating surface ÷ total heating surface, per cent	6.56
Weight on drivers ÷ total heating surface	52.80
Total weight ÷ total heating surface	79.20
Volume both cylinders, cu. ft.	18.50
Total heating surface ÷ vol. cylinders	170.00
Grate area ÷ vol. cylinders	2.90

CYLINDERS.

Kind	Simple
Diameter and stroke	26 x 30 in.

VALVES.

Kind	Piston
Diameter	12 in.
Greatest travel	5½ in.
Outside lap	1 in.
Inside clearance	0 in.
Lead, constant	3/16 in.

WHEELS.

Driving, diameter over tires	73 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10½ x 12 in.
Driving journals, others, diameter and length	9½ x 12 in.
Engine truck wheels, diameter	36 in.
Engine truck, journals	6 x 12 in.
Trailing truck wheels, diameter	49 in.
Trailing truck, journals	8 x 14 in.

BOILER.

Style	Belpaire
Working pressure	150 lbs.
Outside diameter of first ring	72 in.
Firebox, length and width	116 x 66¼ in.
Firebox plates, thickness	⅜ & ⅝ in.
Firebox, water space	5 in.
Tubes, number and outside diameter	160—2¼, 32—5½ in.
Tubes, length	21 ft.
Heating surface, tubes	2,931 sq. ft.
Heating surface, firebox	206 sq. ft.
Heating surface, total	3,137 sq. ft.
Superheater heating surface	641 sq. ft.
Grate area	53.3 sq. ft.
Smokestack, height above rail	183⅝ in.
Center of boiler above rail	111 in.

TENDER.

Frame	12 in. Chan.
Wheels, diameter	36 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	8,000 gals.
Coal capacity	13 tons

ENGINE FAILURES AND HOW THEY ARE OVERCOME.

In a paper on "The Locomotive Repair Shop and Its Proper Organization," presented before the Cleveland Engineering Society, M. D. Franey, superintendent of the Collinwood shops of the Lake Shore, gave some interesting facts concerning engine failures on that road and, also, how, when it is found desirable to change the design of a detail on a locomotive, records are kept insuring the change being made at the first opportunity.

"Before considering the shop organization, I wish to explain one of our record systems used in the Lake Shore main shops, which concerns the safety of the traveling public, as it checks and provides for prompt renewal of parts that may fail in service and cause delay to traffic, or cause accident. The mileage made by all locomotives per engine failure is recorded and a special effort is made by every member of the mechanical and operating departments to reduce these engine failures to a minimum. If a passenger train is delayed three minutes or a freight train ten minutes, on account of the failure of any part of the machinery on the locomotive, or the boiler not providing sufficient steam, or a failure of one of the many intricate parts of the safety appliances, it constitutes an engine failure. The following table shows the mileage made per engine failure in 1903, 1905, 1907 and 1908:

ENGINE FAILURES*—ALL DIVISIONS

	PASSENGER			FREIGHT			TOTAL		
Year	No. Failures	Mileage	Miles per Failure	No. Failures	Mileage	Miles per Failure	No. Failures	Mileage	Miles per Failure
1903	2,048	6,632,855	3,238	2,082	9,499,212	4,562	4,130	16,132,067	3,903
1905	1,521	7,587,790	4,987	2,079	10,531,247	5,065	3,600	18,119,037	5,033
1907	937	8,857,473	9,453	1,144	11,725,916	10,249	2,081	20,583,389	9,891
1908	439	8,491,650	19,343	852	9,702,851	11,388	1,291	18,194,501	14,094

"It will be observed that a marked increase of miles per engine failure has been made in the time specified.

"One of the means of reducing these engine failures is the constant study by motive power department members to improve the design of such locomotive parts as fail in service. Sketches of defective parts showing the defects marked in red are forwarded to the mechanical engineer and properly checked by each department head. Where the records show that these parts are breaking owing to weakness in design, the design is strengthened or changed to correct the defect and instructions for the application of improved parts are issued on manifests accompanied by necessary blue prints approved by the mechanical engineer. The manifests contain instructions as to when the parts are to be applied. The change of such details are termed 'change-in-progress,' and it is very necessary that a simple and comprehensive system be installed to insure the carrying out of these instructions on a railroad with over 1000 engines.

"Each engine is individualized by number; they are classified

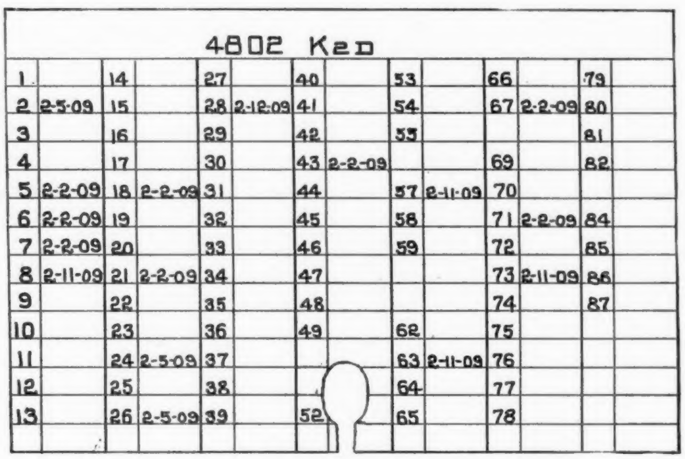


FIG. 1.

by a letter to denote design, sub-divided by a numeral and at times a letter following the numeral to show some changes in detail of the same design. The 4800's, or the Lake Shore fast passenger Pacific engines, are known as class K-2; they are sub-divided into A, B, C, D or E. All of the 4800 engines are Pacific type. They are a class K-2 engine, but there are some slight differences in the detailed construction, which sub-divides them into class K-2A, K-2B, etc.

"We maintain in the general foreman's office a set of cards known as the 'change-in-progress' cards. A card, similar to Fig. 1, is provided for each engine on the division. You will note it has two columns, one on the left for consecutive numbers, 1, 2,

* See also pages 461 and 462 of the December, 1908, issue.

3, etc., and a column to the right of these numbers for the month, day and year. A master card, similar to Fig. 2, or several if necessary, is provided for each class of engine. The master card has numbers corresponding to the numbers on the individual card. It also has to the right, a space showing when the change is to be made. 'F.S.' indicates 'first shopping'; 'R' indicates 'renewals.' A space follows for a brief description of the change to be made or the item of work, and following that is a column for the authority or manifest number. You will readily see that No. 5 on the master card, Fig. 2, defines No. 5 on the individual card, Fig. 1, and saves and prevents the duplication of work. The card for the individual engine has merely the number of the item and to the right a space for the date when the repairs are made.

"We will follow a case of repairs to an engine coming to the

NUMBER	CLASS OF REP'R.	K2 A, B, C, D	AUTHORITY
1	FS	INJECTOR RODS CHANGED FROM HEAD TO SIDE OF FIREMANS SEAT	ARA? LETTER 5-20-08
2	FS	CAB BRACES CHANGED TO BACK HEAD	MDF'S LETTER
3	FS	REVERSE LEVER QUADRANT ON BACK HEAD	T-41504
4	FS	BABBITT IN MAIN ROD BRASSES	14102
5	FS	" " DRIVING BOX "	13698
6	FS	POUR DRIVING BOX HUB FACES BRASSES & SHIMS	
7	FS	CAST IRON HUB LINERS WITH BR. DR. BOX HUB FACES	
8	FS	TRAILER SPRING SEAT TURNED DOWN TO CLEAR GUIDE	T-40384 A
9	FS	TENDER TRUCK BRAKE RIGGING CHANGE LEVER BRAKE HEAD & HANGERS	V-41404
10	FS	BRAKE HANGERS ON TENDER TRUCKS	RBK? 12-27-07
11	FS	FRAME FILLING PIECE SIZE OF PIN CHANGED	T-40327 B

FIG. 2.

shop and select engine 4802, one of the Pacific type. When the engine arrives at the shop for repairs, its individual card is taken from the case; from this we find the engine to be class K-2A. Master cards for the class K-2A are taken from their case and all items to be changed at this shopping, and not dated on the individual card, are typewritten and each sub-foreman interested is given a copy of this report, which is termed the 'change-in-progress repair sheet.' The foreman immediately orders the necessary material to make these changes, and as each item is completed, he enters the date on the change-in-progress sheet. This change-in-progress sheet is returned to the general foreman's office when the repairs to the engine are completed and a clerk enters the date on the individual card to the right of the number indicating that the change has been made. This closes the item referred to for all time and provides a suitable and permanent record of changes in progress."

LOCOMOTIVE CRANK PIN LUBRICATOR.

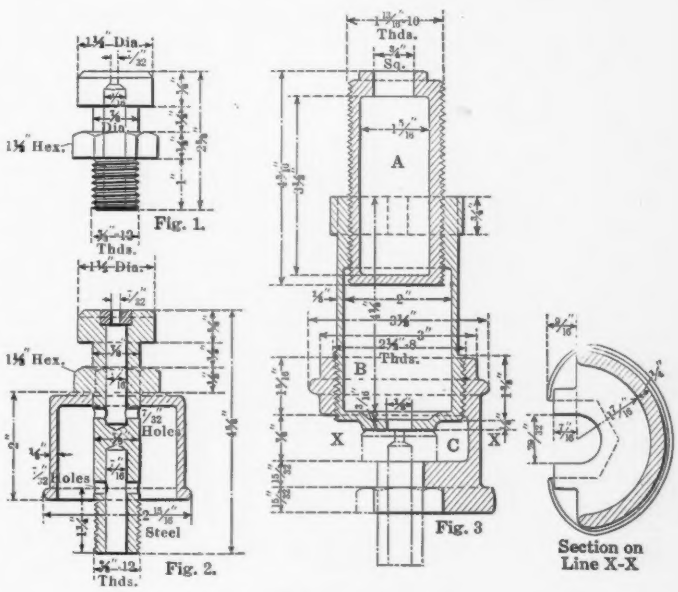
A radical departure from the usual grease cup for the lubrication of crank pins with hard grease is shown in the accompanying illustrations. This device has been invented and patented by a practical railroad man of many years experience and has been adopted by one large railway system with great success. It has not only shown a decided saving of grease, but it has eliminated all losses of grease cups and parts which formerly averaged nearly 1000 plugs and cups per month. In fact at one shop where the device is on every engine on the division, the services of a machinist who formerly put in his time entirely on grease cups has been dispensed with.

Figure 1 shows the receiving plug for side rods, containing a small reservoir and designed with a lip at the top for receiving the portable lubricator shown in Fig. 3. This small receiving plug will hold enough lubricant for a 500-mile trip. In Fig. 2 is shown a receiving plug for main crank pins, having a storage chamber holding a sufficient supply of grease for all requirements, even of abnormal conditions on main pins. The storage chamber is in the form of an inverted cup, held in place by the plug and makes a joint with the top surface of the rod. This is filled in the same manner as the other plug.

In Fig. 3 is shown the portable lubricator which is used for filling the receiving plugs; one of these is carried in a special standard in the locomotive cab to be used in emergencies and the roundhouse men, who fill the lubricators, are provided with others. It consists of three malleable iron castings, A—compressor screw; B—compressor barrel; C—lubricator stand. The stand is designed so that its base will slip into the grooves of the receiving plugs and interlock with the hexagonal top, so that when the compressor screw, turning with it the barrel, is forced down, a perfect joint is made with the upper part of the receiving plugs. The lubricant is then forced into the receiver and a turn with a spanner wrench, which goes with the lubricator, releases it. This portable lubricator holds eight ounces of hard grease.

It has been found necessary to fill the receiving plugs at the start of the trip only and this is done by the roundhouse men assigned for such duty. In cases of emergency where it is necessary for the engineer to lubricate, it has been found that he can do it with this type of lubricator in about one-quarter of the time required with the old style compression grease cup.

The design of receiving plugs is so light that there is no chance of them coming loose and there are no jam nuts to loosen up



NEW TYPE OF GREASE CUP.

and become lost. On the road where these cups are in use it has been found that not a plug has been lost or a hot pin occurred on an engine equipped in this manner.

This device was invented and has been patented by W. H. Dupree, Vicksburg, Miss.

Road Maintenance and Automobiles.—According to the report of the engineers in charge of the State roads of Massachusetts, a little over one-half the current year's estimate for resurfacing and treating the highways under their care is due to the additional burdens of automobile traffic. This figure amounts on the average to about $500 per mile of road 15 ft. in width. The figures given are, to a certain extent, cumulative for more than the past year, the total being, however, exclusive of the amount required for ordinary repairs and care. Of course, the damage is very unequally distributed. One stretch of wide macadam street resurfaced in the spring at a cost of about $5,000 per mile was entirely ruined in a year, almost wholly by motor cars, other traffic being rather light. While probably the additional charge of $500 per mile of upkeep would hold fairly well as an average were traffic uniformly distributed, the amount required on roads where motoring is common may be much larger.—*The Engineering Record.*

HIGH DUTY BELTING.

The user of belting should familiarize himself with the properties of the various types of it in order to select the one best suited to the conditions with which he has to contend. For average railroad shop work a high-grade leather belting will prove most efficient and economical, but on certain classes of wood-working machinery, where the service is severe, a well-made balata belt will give better results. This belting is also waterproof and is less affected by the action of oils, acids, steam and alkalies than any other type of belting, thus being most suitable for application where these qualities are desirable. It mav be used to special advantage where it is exposed to weather conditions, or for axle lighting drives on passenger trains. It is said that a belt of this type was used for driving the axle generator on a Rock Island passenger car which run 116,000 miles when the belt was lost, although still in good condition. The best records for other types were 70,000 miles for a chain belt and 40,000 miles for a rubber belt.

Balata is made from the sap of the boela tree, which is a native of Venezuela and Guiana. In some respects it is similar to rubber, although it does not have the same odor and has very little elasticity. It does not oxidize or deteriorate as does rubber. Cotton duck when impregnated with the balata is acid and waterproof. If there is a tendency for the belt to slip a slight heating softens the balata, increasing its adhesive properties, causing it to grip the pulley. As it thus becomes practically a positive drive it is not suitable for purposes where belt slippage is desirable, or necessary. It also makes it unsuitable for use in places where the temperatures are much above 100° F.

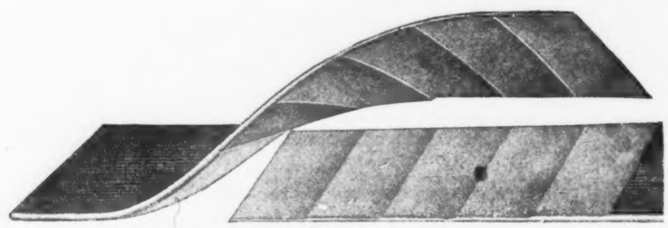
One of the best-known grades of this type of belting in use in this country is known as the Victor-Balata, manufactured by the New York Leather Belting Company. This company has spent a number of years in experimenting with it in order to determine the classes of work for which it is best suited. We are indebted to them for the following facts concerning its manufacture, characteristics and application. It is practically twice as strong as the best leather belting, having an average tensile strength of 8,800 pounds per square inch. In its manufacture a 37-ounce duck is used, which is woven from long staple cotton yarn, the threads being under high tension during the operation. Because of the special method of weaving, its tensile strength is considerably greater than is possible with the class of duck that it is necessary to use in the manufacture of rubber belting, and the percentage of stretch is very small. The balata is forced into the duck, which is thoroughly impregnated with it. The duck is then cut to width for the various sizes and plies, so that only one piece of fabric is used for a belt; there are thus no longitudinal seams running through it. The machinery for forming the folds is so designed as to eliminate any possibility of wrinkles or air cushions. Because of its greater tensile strength it may be used in lighter plies than other classes of belting. As the stretch amounts to only about two per cent. it is necessary to cut the belt more nearly to the exact length than is ordinarily done where users figure on a belt stretching from three to five per cent.; this also reduces the cost of maintenance. The construction of the belt is such that it operates with the least possible vibration, thus being of special value for use at high speeds.

LACING TEXTILE BELTS.

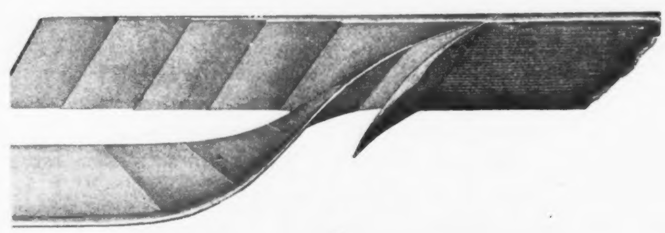
It is necessary to use greater care in lacing or fastening a textile belt of this kind than in the case of leather. Punching too large a hole or placing it too close to the ends of the belt is liable to result in tearing the fastener out. In place of punching the holes it is better to force an awl through the belt, so as to spread the strands apart and tear them as little as possible.

The following suggestions for lacing textile belts are furnished by the New York Leather Belting Company: In preparing the ends of a belt for lacing or fastening, invariably use a square so that they will be at right angles with the edges of the belt. It has often been found, where fasteners do not give entire satisfaction, that it is due to the fact that the ends have not been cut true; consequently, when joined together the strain is not evenly distributed across the width of the belt, falling more on some points than on others and resulting in the tearing out of the fasteners.

What is practically an endless belt sewed with raw-hide thong is shown in Fig. 1. In joining a Victor-Balata belt in this manner the ends are cut to form what is called a "step splice." The plies of the two ends are cut away as in A and B so that when the ends are overlapped the belt is of uniform thickness throughout its length. Balata cement is applied between these overlapped ends and the splice is reinforced with the raw hide. The number of stitches taken with the rawhide lace is dependent upon the width of the belt, as is also the number of rows. The holes should be from 1 inch to $1\frac{1}{4}$ inch apart and they should not



A



B

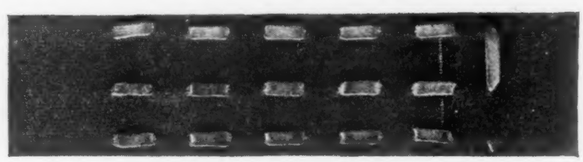


FIG. 1.

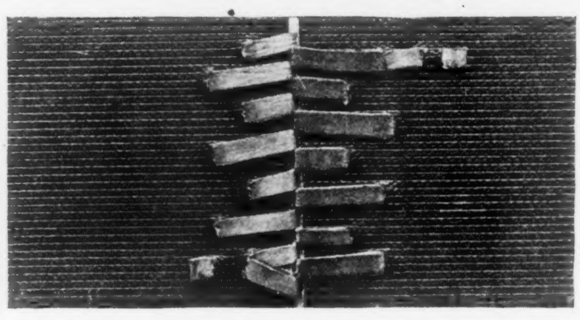


FIG. 2.

come closer to the edge than $\frac{1}{2}$ inch in narrow belts; in wider belts this margin should be slightly increased. The rows of stitching running lengthwise with the belt should be from 1 inch to $1\frac{1}{2}$ inch apart.

$\frac{1}{4}$ in. lace should be used for belts 3 in. and under.
5/16 in. lace should be used for belts from 4 to 8 in.
$\frac{3}{8}$ in. lace should be used for belts of greater width.

In no case should a punch be used for the making of the holes. Use a sharp-pointed awl, spreading apart the fibers, making an opening sufficiently large for the lacing, severing as little of the duck as possible. It is very important that the points of the splice be over-stitched in the manner illustrated, otherwise they may work free and result in tearing the belt. This form of joint is not advocated for very small pulleys, as the stitches, to

some extent, lessen the surface contact and if the load is heavy there is a possibility of slippage where the joint is formed.

The regular form of rawhide lacing is illustrated in Fig. 2. Little need be said of this method except to urge the greatest care in the proper spacing of the holes, so that the strain is evenly distributed, and the selection of a size of lacing in proportion to the width and thickness of the belt.

A hinge joint made with the alligator fastener is shown in

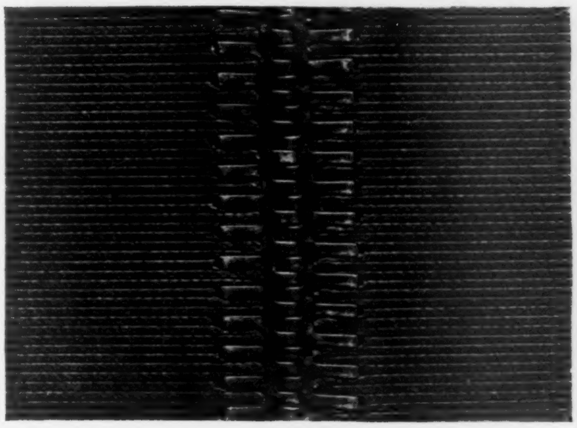


FIG. 3.

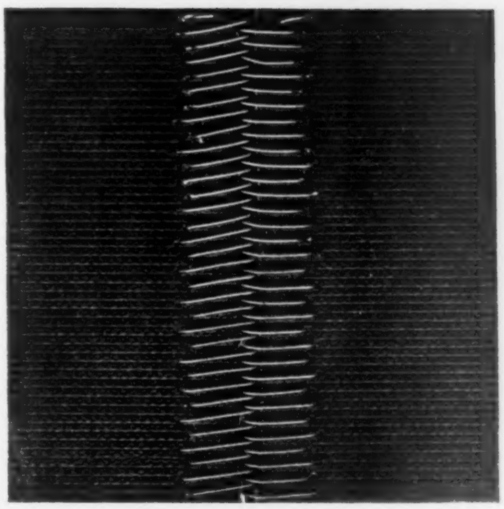


FIG. 4.

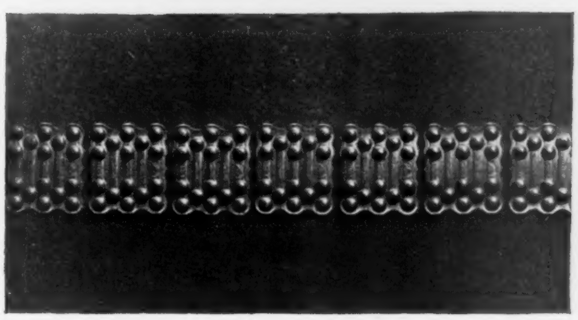


FIG. 5.

Fig. 3. The prongs are merely driven into the belt and clinched on the opposite side. This fastener is made in various sizes for belts of different thicknesses. The teeth of the fastener should be long enough to gain sufficient grip. The hinge is made by the insertion of a rawhide pin and when properly hammered down there is not much metal to come in contact with the pulley surface. This is a very efficient type of fastener to use and will be found satisfactory on belts of moderate width where the loads are not excessive. The rawhide pins will prove very durable, but should be examined from time to time and occasionally replaced.

A machine-made wire hinge joint, having the same advantage of flexibility, is shown in Fig. 4. This also works on a rawhide pin, and when the quality of the wire is right will stand greater strains than the alligator fastener, but its application requires a little more time. The machine used to make this form of joint is of inexpensive and simple construction.

The Crescent fastener (Fig. 5) is a fairly well known one, and this has been found extremely satisfactory where the upper side of the belt has no pulley contact. If the right size plate and rivet is used this fastener may be successfully operated on very small pulleys, and owing to the fact that the split copper rivet makes a small hole and spreads rather than cuts the fabric, the strength of the belt remains intact and will stand severe strains where joined.

The Jackson fastener (Fig. 6) is particularly desirable for heavy belts. The inside of the plate being slightly hollowed and the disc that goes on the pulley side being slightly convex, admits of this disc being drawn well up into the plate when the countersunk nut is tightly screwed down. This results in the belt being held in a vice-like grip and the strain is not to any great degree thrown on the bolt that passes through it. It is made in a number of sizes suitable for different widths and plies of belting, and is strongly advocated for use on heavy Victor-Balata belts. The hole for the belt should be made no larger than absolutely necessary to force it through. It is advisable to place between the upper surface of the belt and the plate what

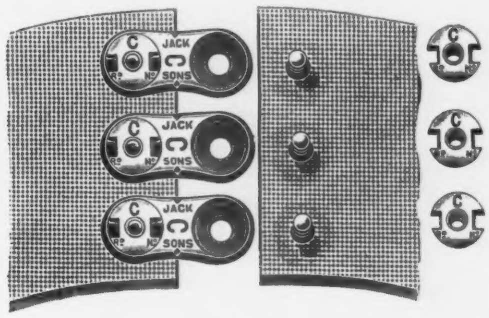


FIG. 6.

is termed a "safe," which should consist of two plies of balata belt, which is made in this form, or which may be cut from some remnant; this will prevent the plate breaking or cutting the belt's surface as it goes around the pulley.

OIL HOUSES.—The committee on buildings of the American Railway Engineering and Maintenance of Way Assn. made a study of the design of oil houses last year. Their conclusions as amended at the annual convention in March are as follows:

"(1) When practicable, oil houses should be isolated from the other buildings at a terminal.

"(2) Oil houses should be fireproof and the storage in large houses should preferably be either underground or in the basement.

"(3) Oils that are stored in sufficient quantities should be delivered to the tanks in the house direct from tank cars. For oils that are stored only in small quantities provision should be made for delivery to storage tanks from barrels by pipes through the floor.

"(4) The delivery system from the storage tanks to the faucets should be such that the oil can be delivered quickly and measured. The delivery should also be such that there will be a minimum of dripping at the faucet and that the drippings be drained back to the storage tanks."

HIGH SPEED UPRIGHT DRILL.

It has been a difficult task to improve the upright drill to make it powerful enough to use the high speed steel drills to advantage, in addition to providing other improvements which are desirable from the standpoint of increasing the output, as well as adding to the convenience in operation. A machine of this type has been developed during the past few years by The Cincinnati Bickford Tool Company, of Cincinnati, which fulfils these conditions to a remarkable extent, as may be seen from a study of the following description.

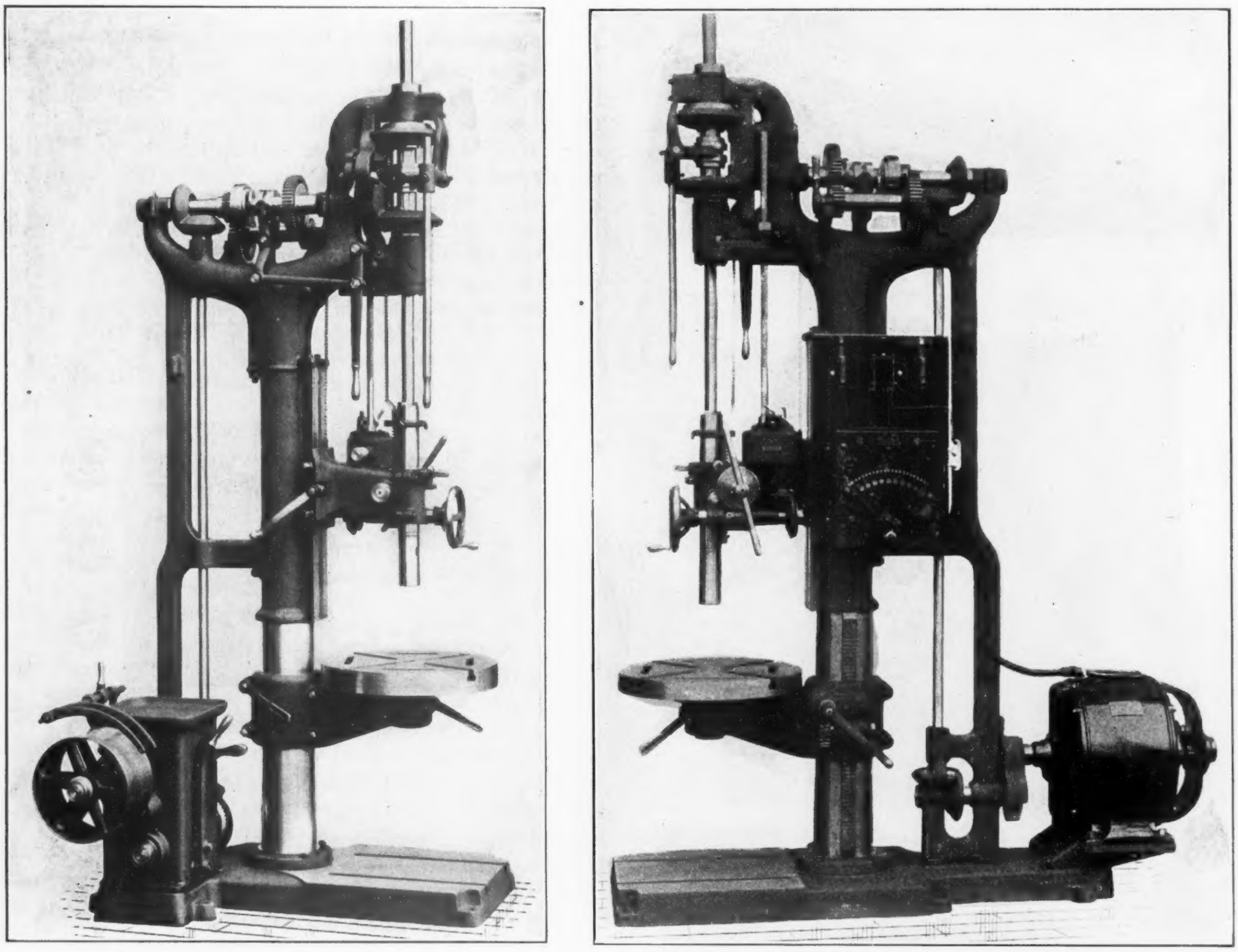
The column of large diameter is well braced and rests on an unusually heavy base, carefully designed to make it as rigid as possible. The base is also provided with T slots for holding the work. The head is counterbalanced and is vertically adjustable by means of a steel rack and pinion; it has a wide bearing on the column and may be quickly and securely clamped in any position. The table is of heavy construction, is well reinforced and has a large bearing on the arm which is hand-scraped, insuring perfect alignment. The table arm is raised and lowered by a rack and pinion and a worm and wormwheel; it is thus not possible for it to drop by accident.

The spindle is provided with ball-bearing and jam nuts for adjustment, and has an automatic stop so that holes may be drilled to a fixed depth. A patent positive geared feed box is located on the sliding head, convenient to the operator, and provides six feeds. For the 24, 28 and 32-inch machines these feeds are 0.006, 0.009, 0.013, 0.018, 0.027, and 0.039 inch per revolution of the spindle. For the 36 and 42-inch machines they are greater.

The friction back gear at the top of the machine may be left in continuous engagement, although a handle is provided to disengage it when not in use. The lever for manipulating the back gear extends down near the front of the machine at the left, convenient to the operator; with it he may engage or disengage the back gear without stopping the machine, although the spindle may be stopped by bringing the lever to a neutral position; this feature has proved to be of great value. If desired, these machines may be furnished with a tapping arrangement, as shown, whereby the tap may be operated at a slow speed until it is reversed, when the speed is four times as great.

The belt driven machines are equipped with a gear box. It is placed at the left in order that the operator may change the speeds without leaving his position; eight speeds are obtained through it, thus making sixteen spindle speeds available in connection with the back gears. The time required for making any change of speed is not more than three or four seconds. The box contains no frictions and is of simple and substantial construction; its top furnishes a convenient tool tray.

With a motor drive the motor is mounted on a bracket at the rear; the switchboard containing the controller and switches is placed on the side of the column. The Triumph motor on the drill shown in the illustration, furnishes eighteen different speeds, which, in connection with the back gears, provides thirty-six spindle speeds. A 3 h.p. motor is recommended for the 24-inch machine; a 5 h.p. for the 28 and 32-inch; and a 7½ h.p. for the 36 and 42-inch. The drive for both belt and motor-driven machines is arranged to furnish a cutting speed of seventy feet per minute for the different size drills. An index plate indicates the



CINCINNATI-BICKFORD IMPROVED HIGH SPEED UPRIGHT DRILL.—BELT AND MOTOR DRIVEN.

Size of machine	24″	28″	32″	36″	42″
Height of drill, regular machine	7′ 5½″	8′ 0″	8′ 5″	8′ 11½″	9′ 3″
Height of drill, tapping machine	8′ 3½″	8′ 11″	9′ 4½″	9′ 11½″	10′ 3½″
Drills to center of	25″	29″	33″	37″	43″
Distance between base and spindle	48″	52″	54″	57″	58″
Distance between table and spindle	35½″	37¼″	38½″	39½″	38¾″
Traverse of table on column	19¼″	19¼″	18¾″	18½″	19″
Traverse of head on column	21¼″	22¾″	24¼″	26¾″	24¾″
Diameter of table	22″	25″	28″	32″	36″
Horsepower required	3	5	5	7½	7½
Weight, pounds, about	2.700	3,500	4,000	5,200	6,100

position of the levers for using the various size drills at a cutting speed of 70 ft. per min.

The table on the opposite page gives the general dimensions of the different sizes of this line of drills.

TWO-SPEED PLANER DRIVE.

An ingenious arrangement has been contrived by The Cincinnati Planer Company, Cincinnati, Ohio, for providing two cutting speeds and a constant return speed on its smaller size belt-driven planers—22 to 36 inches. At the extreme right on the countershaft, shown in the illustration, is the large pulley for driving the return belt. Next to this, and not shown clearly, are three 16-inch pulleys set closely together. The one nearest the return pulley is narrow and keyed to the shaft; the other two are loose, the first one being quite wide and the other one narrow. Beyond these on the countershaft, are three pulleys—a small one for driving the elevating pulley, and two wide pulleys, one keyed to the shaft and the other one running loose. The tight pulley at the left is connected to the line shaft and drives the countershaft and thus the return pulley, and also furnishes the high cutting speed when the cutting belt is on the narrow pulley next to the return pulley. To change to a slower cutting speed the cutting belt is shifted to the wide loose pulley, which is driven at a slower speed by a belt from the line shaft, the pulley being wide enough to accommodate both belts. To stop the countershaft the two driving belts are shifted to the loose pulleys at the left of both sets of pulleys. The cutting speed may of course be changed while the machine is in operation, the belts being shifted by the lever at the side of the housing.

"HIGHPOWER" DRILLS.

A high-speed twisted drill that does not require special chucks or sockets, has recently been placed on the market by The Pratt & Whitney Company, Hartford, Conn. The increased twist in the shank permits its use with the standard Morse or other taper sockets. The drill is ground on the shank and barrel so that it has the same accurate alignment as the standard milled drill. The twisted shank is claimed to provide an even more effective contact with the socket, thus making possible the use of greater driving power, than does the ordinary solid shank. The breaking of tangs and the slipping of drills is eliminated.

The first two tests described below were made to determine the efficiency of the drill in machinery steel and cast iron, no effort being made to find the limit of the tool. The third test was made to determine the effective contact between the shank and the socket and the general strength of the drill.

Test No. 1.
Diameter of drill, 1¼".
Material drilled, machinery steel, 3½" thick.
Cutting speed per minute, 98 feet.
Feed per revolution of drill, .0145.
Inches drilled per minute, 4.2.
Number of holes drilled, 100.

At this point the drill was removed and found to be in practically as good condition as when test commenced.

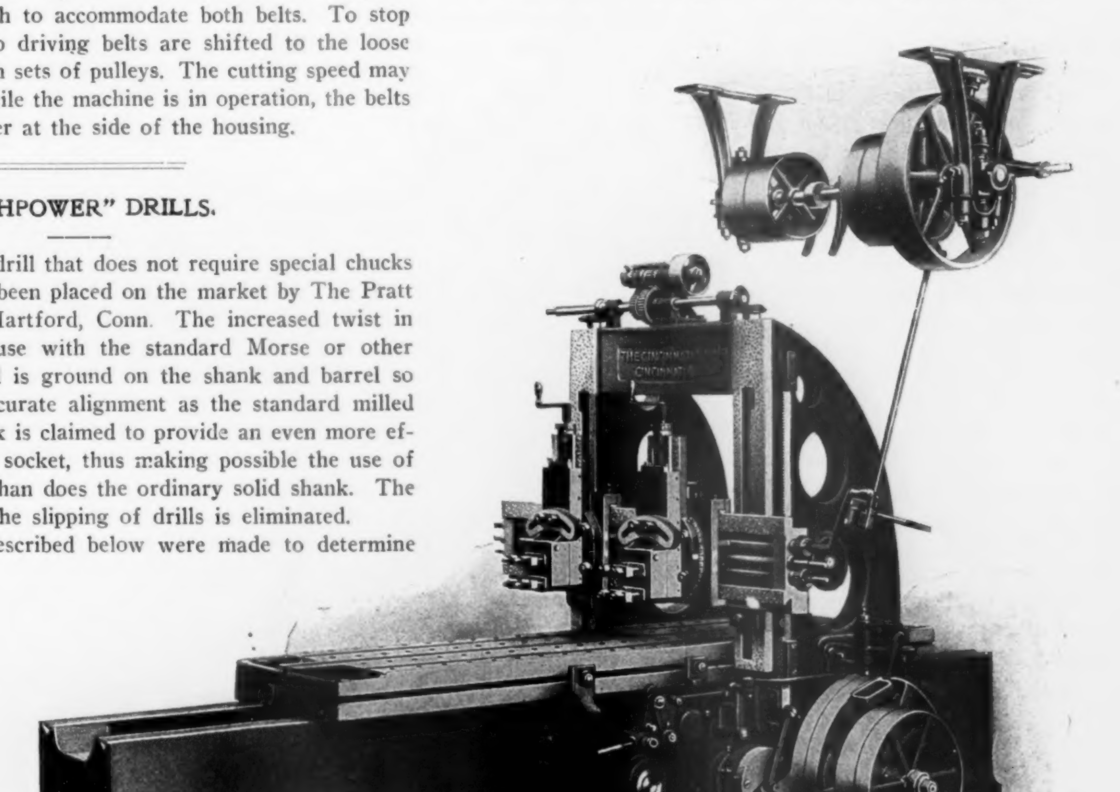
Test No. 2.
Diameter of drill, 1¼".
Material drilled, cast iron, 3" thick.
Cutting speed per minute, 127 feet.
Feed per revolution of drill, .0426.
Inches drilled per minute, 14.9.
Number of holes drilled, 211.

PRATT & WHITNEY "HIGHPOWER" DRILL.

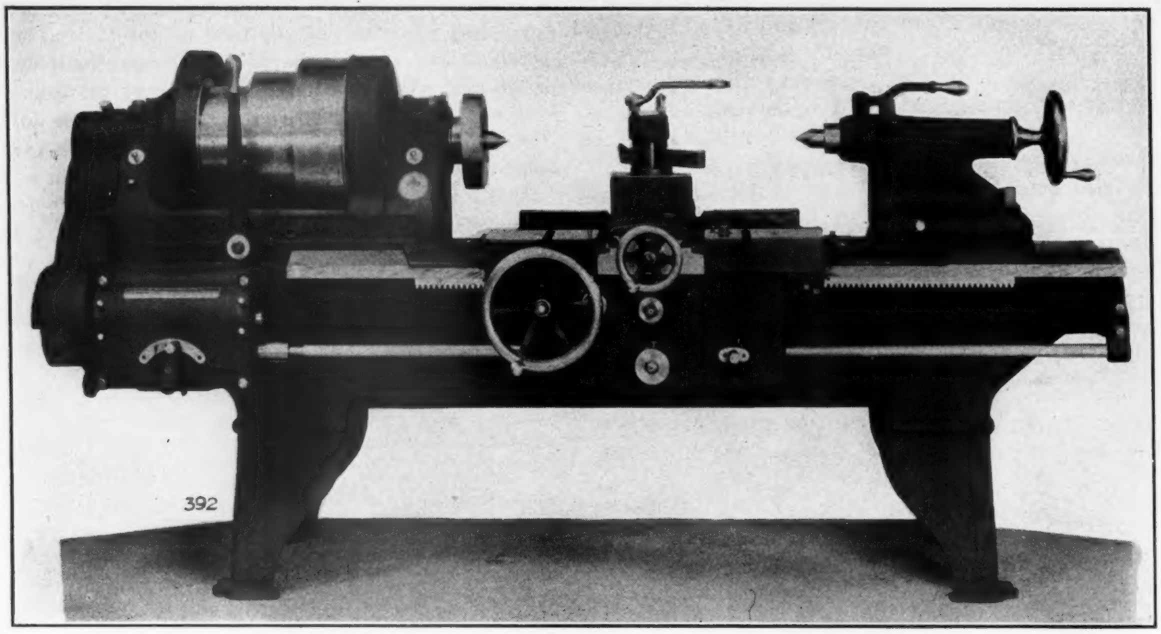
At this point the drill was removed and found to be in practically as good condition as when test commenced.

Test No. 3.
Diameter of drill, 1".
Material drilled, cast iron, 2¾" thick.
Cutting speed per minute, 156 feet.
Feed per revolution of drill, .087.
Inches drilled per minute, 51.9.

The drill was removed after drilling one hole, without a sign of a flaw and cutting edges found to be in good condition.



A 30 X 30 IN. BY 8 FT. CINCINNATI HEAVY PATTERN PLANER WITH TWO-SPEED DRIVE.



LE BLOND HEAVY DUTY LATHE.

HEAVY DUTY LATHE.

In the September number, page 374, we described a new line of heavy duty engine lathes that has recently been placed on the market by The R. K. Le Blond Machine Tool Co., of Cincinnati, Ohio. There is a considerable amount of work in railroad shops, especially on the smaller size lathes, where a simpler machine with fewer speed changes and special attachments may be used to just as good advantage as the more complicated and expensive ones. The lathe shown in the illustration, which is made in three sizes—16, 18 and 20-inch swing—has been designed to meet this need.

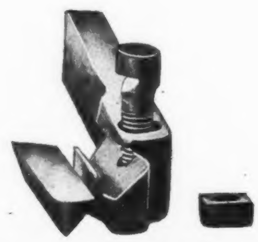
The headstock retains the same features as the one on the machine described in the September issue, with the exception of the back gearing. Instead of the double friction back gear with its quick changes, which are so essential in a general purpose tool, the double back gears are engaged with a sliding key operated by the hand lever directly in front of the driving cone. The usual quick-change box is replaced by a four-change feed box. The changes are obtained by sliding gears operated by the crank handle shown on the front of the box, and may be made while the machine is in operation under the heaviest cut. These four changes are doubled by a reversible compound gear on the end of the bed which gives the operator a choice of eight geared feeds, covering a carefully selected range.

The apron is double-walled, of a single box section casting, as previously described. The lead screw and half nuts are stripped off. The manufacturers state that they are prepared to furnish this apron with automatic stops for the cross and longitudinal feed, of a construction similar to what they have been using on their high-speed roughing lathes for several years. In all other respects the lathe is similar to the one described last month.

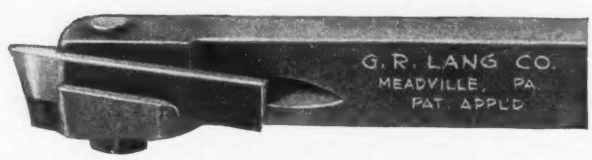
A NEW TOOL HOLDER.

The tool holder shown in the accompanying illustrations is made by The G. R. Lang Company, of Meadville, Pa., and contains a number of features of merit, which makes it particularly well adapted for many of the most difficult railroad shop operations. It is designed to take the place of large solid forged tools on the class of work for which the ordinary tool holder has proven to be too light. It is intended primarily for heavy roughing work such as turning locomotive driving axles, but it has also been shown to be satisfactory for light and finishing cuts.

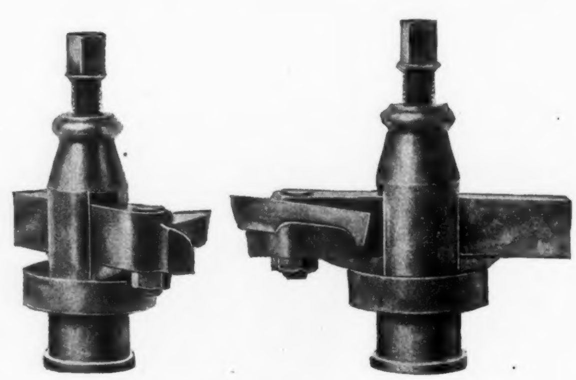
Special points of advantage of this tool holder are found in the large area of the cutting point, which gives a liberal radiating surface; the support underneath the cutter at a point directly opposite the thrust of the cutting edge; the use of triangular-shaped cutters, which permit a great saving in the cost of the steel; unusual rigidity, due to the use of the triangular cutter,



LANG TOOL HOLDER DISMANTLED.



LANG TOOL HOLDER WITH TRIANGULAR CUTTER.



LANG TOOL HOLDER IN TOOL POST.

which is seated in a V-shaped slot; the absence of set screws and tapped holes in the holder; the absence of obstruction in the way of the chip coming off of a heavy cut and the shape of the holder, which permits it to work up very close to a shoulder or face.

The use of triangular steel for the cutters gives a liberal depth under the cutting edge, together with proper side and top clearances, without waste of steel in grinding. This makes a very economical cutter, which weighs but one-half as much as it would in a square section. The triangular steel can be bought in bar lengths as readily as in other sections. The method of clamping and supporting the cutter practically eliminates the possibility of the point springing down or backing away from the work. The illustrations show the method of clamping the cutter to the holders which are made in rights and lefts, being set and used the same as a solid forged tool would be. Special shaped shanks are provided for use in a vertical boring mill.

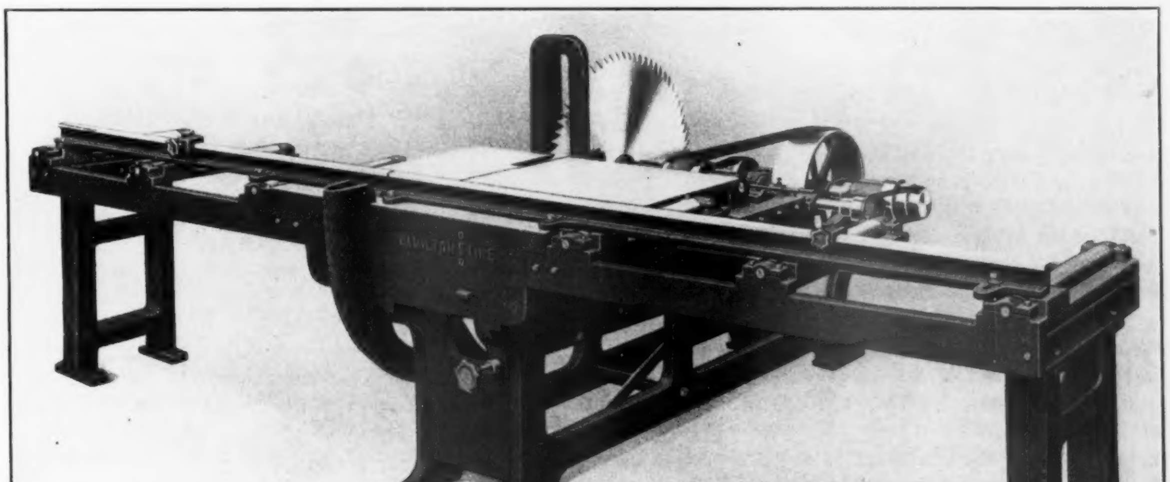
In railroad shops where these cutters have been tried it was found that in competition with solid forged tools the holder not only saved tool steel and the cost of forging, but also increased the output of the machine quite noticeably, largely on account of the small amount of time consumed in grinding the cutter point. The manufacturers of this holder fully guarantee that it will take as heavy cuts as a solid forged tool and the experience in shops that have been using them indicates that this can be done in practically all cases.

HEAVY AUTOMATIC RAILWAY CUT-OFF SAW.

This saw is designed for medium and heavy work in car shops, shipyards and for heavy building material. It is ordinarily furnished with a thirty-inch saw, but will take saws up to thirty-six inches, which will cut off material up to 27 by 9 inches or 17 by 14 inches. The table is of extra large size, consisting of a central connected portion four feet in length and having long wing roller extensions, giving a total length to the table of thirteen feet. The roller table is thirty inches wide and will admit material twenty-seven inches wide.

The frame is of heavy construction, well braced throughout and is eight feet five inches long over-all from front to back. The table is thirteen feet long from end to end. The saw is driven by an improved drive consisting of an endless belt running over the various pulleys and idlers in such a manner as to maintain straight lines between the pulleys, thus maintaining equal tension on the belt at all times and doing away with swinging frames or idlers.

The saw housing travels on top of the frame in heavy dovetail slides and is provided with adjusting gibs for taking up wear and for lining up the saw. The housing is fed by means of a heavy lead screw driven by right and left friction gearing, which is controlled by a foot treadle at the front of the machine. There are three rates of forward feed and one return. The housing may be started or stopped at any point in its travel and may be returned to its starting point at the will of the operator. A stop rod is furnished by which the backward travel of the saw may be regulated, as it is not necessary to return it for the full stroke at every cut made. The countershaft is attached to the machine and has tight and loose pulleys, 14 inches in diameter with 8¼ inches face, which should make 250 revolutions per minute. The machine weighs about 3,000 pounds, requires from 15 to 25 horse-power and occupies floor space of 13 by 8½ feet. It is known as the Hamilton heavy automatic railway cut-off saw, No. 118, and is manufactured by The Bentel & Margedant Company, Hamilton, Ohio.



HAMILTON HEAVY AUTOMATIC RAILWAY CUT-OFF SAW.

BELT DRESSING.

After a belt has been in use some time, its surface takes on a glaze. This results in losses due to slipping, always accompanied by heating, and draws the natural oils to the surface, causing them to evaporate. This condition further leads to the belt's getting stiff and hard, and lessens the angle of wrap (the angle between the extreme points touched and covered by the belt on the pulley). Without attention belts are almost sure to deteriorate in this way. To prevent the formation of surface glaze and the slipping accompanying it, it is the best practise to use a reliable belt dressing. This dressing should be of a nature that will not only offer temporary relief, but that will penetrate through the surface of the belt and replenish the natural oils. This will result in keeping the belt pliable and preserving the original efficiency.

Rosin is very frequently applied to prevent slipping, and this it will do, but at the same time it destroys the life of the belt itself. It furnishes temporary relief, but greatly shortens the life of the belt—the rosin dries out the belt and makes the leather fibers brittle.

A belt dressing is made by the Joseph Dixon Crucible Company, Jersey City, N. J., which it is claimed does not supply a surface stickiness, but is absorbed by the belt, thus keeping it in its natural condition, preventing the formation of surface glaze with the attendant slipping, and maintaining the angle of wrap at its widest points.

RAILROAD CLUBS.

Canadian Railway Club (Montreal, Can.).—Tuesday evening, October 5th, C. Kyle, general master mechanic of the Canadian Pacific Railway at Montreal, will read a paper on "Locomotive Dispatching and Terminal Facilities."

Mr. Vaughan's paper on "Locomotive Counterbalancing," presented at the September meeting, is reproduced in another part of this issue.

Secretary, Jas. Powell, P. O. Box 7, St. Lambert, near Montreal.

Central Railway Club (Buffalo, N. Y.).—At the meeting for November 12th, G. Herbert Condict, secretary of the International Lecture Institute, will read a paper on "The Application of Electricity to the Movement of Miscellaneous Terminal or Package Freight for Railway and Steamship Companies."

At the September meeting, Col. B. W. Dunn gave an illustrated talk on the "Railway Official's Responsibilities and Duties in Connection with the Transportation of Dangerous Articles."

Secretary, Harry D. Vought, 95 Liberty street, New York City.

Iowa Railway Club (Des Moines, Ia.).—Next meeting, Friday, October 8th. Secretary, W. B. Harrison, Union Station, Des Moines, Ia.

New England Railroad Club (Boston).—The next regular meeting will be held at Copley Square Hotel, October 12th. Dinner will be served at 6:30 o'clock, to be followed by the regular business session at 8:00 o'clock. William J. Cunningham, statistician of the Boston & Albany Railroad, will read a paper on "Railroad Operating Statistics."

Secretary, George H. Frazier, 10 Oliver street, Boston, Mass.

New York Railroad Club.—Next meeting, Friday, October 15th. At the September meeting Frederick C. Syze, of the Staten Island Rapid Transit Company, presented a paper on "Surprise Efficiency Tests of Employees Charged with the Operation of Trains."

Secretary, H. D. Vought, 95 Liberty street, New York City.

Northern Railway Club (Duluth, Minn.).—At the meeting for October 23d, W. A. Clark, general car foreman of the Duluth, Missabe & Northern Ry., at Proctor, Minn., will read a paper on "Steel vs. Wooden Freight and Passenger Cars; Their Relative Cost, Use and Repairs."

At the meeting of November 27th, W. H. Hoyt, assistant chief engineer of the D., M. & N. Ry., Duluth, Minn., will speak on "Steel vs. Wooden Ties."

December 18th, C. J. Whereat, traveling engineer of the Great Northern Railway at Superior, Wis., will present a paper on "Pooling of Locomotives."

At the January meeting the "Economical and Proper Handling of Material in a Storehouse" will be considered by J. E. Chandler, storekeeper of the Duluth & Iron Range Railway, at Two Harbors, Minn.

"Demurrage, Its Benefits, Necessity, etc.," was the subject of the paper presented at the September meeting by F. L. Flock, chairman of the Missabe Range Car Service Association.

Secretary, C. L. Kennedy, 401 West Superior street, Duluth, Minn.

Railway Club of Pittsburgh.—The subject to be considered at the meeting for October 22d, has not yet been decided upon.

At the September meeting A. D. Smith, superintendent of The Canfield Oil Company, Coraopolis, Pa., presented a paper on "The Technical Selection of Railroad Oils as Applied to Cost Reduction."

Secretary, C. W. Alleman, P. & L. E. R. R., Pittsburgh, Pa.

Richmond Railroad Club.—At the next meeting, October 11th, Capt. A. B. Guigon, assistant counsel for the Virginia Passenger & Power Company, will give an address on the relation to the public of officials and employes of public service corporations.

At the November meeting the annual election of officers will be held and an entertainment will be given to which the ladies will be invited.

At the December meeting it is expected that an illustrated lecture on block signals will be given by Chas. Stephens, signal engineer of the C. & O. Ry.

Col. B. W. Dunn, of the American Railway Association bureau for the safe transportation of explosives, gave an illustrated lecture at the September meeting.

Secretary, F. O. Robinson, C. & O. Ry., Richmond, Va.

St. Louis Railway Club.—At the meeting for October 11th, H. McL. Harding, vice-president of the International Lecture Institute, of New York City, will give an illustrated address on "Terminal Handling of Freight by Electricity."

At the September meeting, C. F. Smith, road foreman of engines of the Terminal Railway Association, of St. Louis, read a paper on coal combustion and economy in the handling and firing of bituminous coal for locomotive use.

Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

Southern & Southwestern (Atlanta, Ga.).—Next meeting, Friday, November 18th. Secretary, A. J. Merrill, 218 Prudential Bldg., Atlanta, Ga.

Western Canada Railway Club (Winnipeg, Man.).—Next meeting, Monday, October 11th. Secretary, W. H. Rosevear, 199 Chestnut street, Winnipeg, Man.

Western Railway Club (Chicago).—The paper for the meeting of October 19th will be from the telegraph department.

At the September meeting George S. Payson, general counsel of the Western Railroad Association, gave an adddress on "The Relations of the Western Railroad Association to Railways and the Manufacturers of Railway Devices."

Secretary, Jos. W. Taylor, 390 Old Colony Building, Chicago, Ill.

Association of Car Lighting Engineers.—The annual meeting of the association of car lighting engineers will be held at the new La Salle Hotel, Chicago, October 4 to 7, 1909. The question of changing the scope of the association will be considered at this meeting.

Monthly Meeting A. S. M. E.—The first monthly meeting of The American Society of Mechanical Engineers for 1909-10 will be held in the Engineering Societies Building, New York, on Tuesday evening, October 12, at 8 P. M. A paper will be presented by Prof. R. C. Carpenter, of Cornell University, upon the High-Pressure Pumping System of New York City. There are two pumping stations comprised in this system which receive power transmitted electrically from several of the electric generating plants of the city. There are five pumping units in each station consisting of 5-stage centrifugal pumps driven by induction motors. Each pump has a capacity of 3,000 gal. per min. and delivers against a pressure of 300 lbs. per square in. in the mains. It is expected that the discussion following the paper will not only bring out information upon these systems, but will also lead to a general presentation of the subject of centrifugal pumps.

BOOKS.

The Protection of Railroads from Overhead Transmission Line Crossings. By Frank F. Fowle. 70 pages, 5x8 inches. Cloth. Illustrated. Published by D. Van Nostrand Company, 23 Murray street, New York City. Price $1.50.

One of the most troublesome problems caused by the advent of high tension power transmission is that of safeguarding persons

and property from exposed transmission lines. In considering the specific case, indicated by the title of this work, the author has not attempted to consider such details as naturally pertain to individual crossings, but has considered the general principles involved and also the materials and the types of construction. The material was gathered and arranged for presentation before the Association of Railway Telegraph Superintendents at their 1908 meeting, but was not completed in time and arrangements were then made for publication in book form.

Efficiency as a Basis for Operation and Wages. By Harrington Emerson. 171 pages, 5x7½-inch cloth. Published by *The Engineering Magazine*, 140 Nassau street, New York City. Price $2.

This is a book which should be, not in the the library, but on the desk of every man who has the efficiency and welfare of the company with which he is connected at heart. The fundamental principles advocated by Mr. Emerson—and they have demonstrated their correctness and great value wherever they have been tried out in practice—must appeal to anyone who studies them carefully. A man with a real message usually finds little trouble in convincing his hearers, if he can only get into personal touch with them, but usually the message loses greatly in force when reduced to writing. Mr. Emerson, however, seems to have forced his very personality into his book. With a wealth of illustration drawn from his broad experience and study, he clearly brings out and "forces home" each important truth, and as we read—and then stop for a moment and look up—we almost expect to see him sitting in the chair opposite.

The book has as its basis a series of articles which were published in the *Engineering Magazine*, but these have been so fully revised, rearranged and enlarged as to make it almost a new statement of Mr. Emerson's system. The *Engineering Magazine* is to be congratulated on adding it to its already valuble "Works Management Library." A rough idea of the scope of the book may be gained from the following list of chapter headings: Typical inefficiencies and their significance. National efficiencies; their tendencies and influence. The strength and weakness of existing systems of organization. Line and staff organization in industrial concerns. Standards; their relations to organization and to results. The realization of standards in practice. The modern theory of cost accounting. The location and elimination of wastes. The efficiency system in operation. Standard times and bonus. What the efficiency system may accomplish. The gospel of efficiency.

THE DRYING OF LUMBER.—When lumber is freshly cut, it is full of water, and this water disappears with more or less rapidity. I may state, without fear of contradiction, that probably the most important item in the handling of lumber is to successfully dry it. As the water disappears, the wood fibers shrink in volume, and cause the outer layer to shrink faster than the inner portion; a series of tension forces are set up, which ultimately result in the formation of splits or cracks in the outer layer. The extent of this splitting or cracking will depend upon the rate of evaporation of the water from the outer and inner layers. Where the water dries out with great rapidity with approximately the same rate, practically no splitting will result. It is on this account that thin lumber will check and split less than thick lumber. Twisting or warping is due to similar causes, that is, one portion of a board will dry faster than another, the fibers will contract faster, resulting in a marked curving in one direction or another.—*Hermann Von Schrenk before the Railway Storekeepers' Association.*

PERSONALS.

F. E. Patton has been appointed road foreman of engines of the Mobile & Ohio Ry., with office at Mobile, Ala.

J. F. Murphy, master mechanic of the Houston & Texas Central Ry. shops at Ennis, Texas, died on September 9.

H. C. Eich, master mechanic of the Illinois Central R. R. at Memphis, Tenn., has been transferred to the Burnside shops, Chicago, Ill.

Walter Hill has been appointed roundhouse foreman of the Delaware, Lackawanna & Western R. R. at Buffalo, N. Y., to succeed Thomas Horton.

A. J. Devlin, bonus expert on the Coast Lines of the Santa Fe, has been appointed machine shop foreman of the Albuquerque shops.

C. W. Lee has been appointed master mechanic of the Raleigh & Southport Ry., with office at Raleigh, N. C., succeeding George L. Womble.

L. A. Larsen has been appointed assistant to Vice-President David Van Alstyne, of the American Locomotive Company, with office in the Hudson Terminal Bldg., New York City.

John A. Lee, shop and engine-house foreman of the Western Allegheny Ry. at Kaylor, Pa., has been appointed master mechanic, with office at Kaylor, succeeding J. H. Marks.

J. E. Weatherford, foreman of the car department of the Houston & Texas Central Ry. at Ennis, Tex., has been promoted to general foreman of the same department at Houston, Tex.

James C. Fritts, foreman at the Hoboken, N. J., shops of the Delaware, Lackawanna & Western R. R., has been appointed master car builder, with office at Scranton, Pa., succeeding Robert F. McKenna, resigned.

T. F. Quinn has been appointed division master mechanic of the Oregon Railroad & Navigation Company and the Oregon, Washington & Idaho Ry., with office at Starbuck, Wash., succeeding W. H. Dressel, resigned.

The office of master car builder of the Chicago, Indianapolis & Louisville Ry., formerly held by C. Coller, having been abolished, the duties of this office will hereafter be performed by John Gill, superintendent of motive power.

J. M. Barrowdale has been appointed assistant superintendent of the car department of the Illinois Central R. R., and A. J. McKillop has been appointed the assistant superintendent of machinery in charge of locomotives, both with office at Chicago.

W. L. Kellogg, superintendent of motive power and car department of the Pere Marquette R. R. at Detroit, Mich., has been appointed superintendent of motive power of the Cincinnati, Hamilton & Dayton Ry., with office at Lima, Ohio, and will have charge of the locomotive and car department.

Prof. H. B. MacFarland has been appointed engineer of tests for the Santa Fe System. He is a graduate of the Worcester Polytechnic Institute and was a graduate student in experimental engineering at Cornell University in 1903. From 1903 to 1908 he was associate professor of applied mechanics and thermodynamics at the Armour Institute of Technology. For the past few years he has been making mechanical and scientific investigations for private corporations and companies as consulting engineer, with office in Chicago.

Capt. J. F. Divine, assistant general superintendent of the Atlantic Coast Line Railroad, died at his home in Wilmington on August 21. Capt. Divine was one of the oldest members of the Master Car Builders' Association and until the last few years had been a very regular attendant. He was born in Scotland in 1830, being brought to this country when a small boy. He started his railroad service in 1851 by superintending the erection of a number of locomotives for the old Wilmington &

Raleigh Railroad, and has been connected with the same line, it now being part of the Atlantic Coast Lines, for 58 years continuously, with the exception of four years during the Civil War. He was for a number of years general superintendent and was relieved of a greater portion of his duties and made assistant general superintendent on account of declining health. His loss will be keenly felt by the older members of the M. C. B. Association.

CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Flexible Transmission.—Bulletin No. 22, from the Coates Clipper Mfg. Company, Worcester Mass., describes the flexible shaft made by that company and illustrates a great variety of devices in connection with which it is used.

Facts Worth Knowing About Grinding Wheels.—This is the title of a booklet received from the Norton Company, Worcester, Mass. It contains much valuable material concerning the selection of the proper grade of wheels for various purposes; also as to the application and care of grinding wheels.

Metallic Packing.—The Morris metallic packing for stationary and marine engines, gas engines, steam locomotives, steam pumps, air and gas compressors is described in a leaflet from the H. W. Johns-Manville Company, 100 William St., New York City.

Drill Grinding.—The Cleveland Twist Drill Company, of Cleveland, Ohio, is sending out with its compliments a leaflet containing a reprint of shop operation sheets, which were issued with the June number of *Machinery*, and which show in a concise form the proper methods of grinding both flat and twist drills.

Anti-Leak Stick.—H. W. Johns-Manville Co., 100 William St., New York, is issuing a leaflet pointing out the value of a new compound, which is put up in stick form and is designed for permanently repairing leaks in all kinds of receptacles, roofs, chimneys, etc. It is not affected by hot or cold weather and can be used on any material for permanent repairs.

Steel Ore Cars.—An attractive folder, designated as "Bulletin No. 10," has been received from The Summers Steel Car Company, Farmers Bank Building, Pittsburgh, Pa. It describes and considers the advantages of the Summers center dump ore car. Drawings and photos are shown of one of a lot of eight hundred cars built for the Duluth & Iron Range Railroad a few months ago.

Portable Electric Tools.—The S. Obermayer Co., 641 Evans St., Cincinnati, O., is issuing a most attractive catalog fully illustrating and describing a complete line of electric drills, hammers, grinders, etc., the electrical part of which is manufactured by the Cincinnati Electrical Tool Co. These portable machines are very highly developed and are shown in many different sizes and forms; the grinders, in particular, being arranged for many special jobs. The descriptive matter is most interesting.

Railway Specialties.—The General Railway Supply Company, 531 Marquette Bldg., Chicago, is issuing a new catalog in which are illustrated in a most excellent manner a number of very high grade devices for use on passenger cars. These include metallic (steel) sheathing; National steel trap door and lifting device; Schroyer friction curtain roller; Garland ventilator; Flexolith composition flooring; roller deck sash ratchet; Imperial car window curtain; Perfection sash balance and National standard roofing. All of these devices are thoroughly practical and each has features of special advantage.

Electric Trucks.—The American Locomotive Company is issuing Bulletin No. 1 from its electric locomotive and truck department, which illustrates and describes the new type S short wheel base electric motor trucks with steel plate side frames. In this booklet are also shown two new adjustable swing link devices, which are applicable to any trucks built by this company with swinging bolsters. One of these devices is arranged for adjusting the height of the car body and the other permits of the same adjustment and also the changing of the angularity of the swing links to suit service conditions and give the easiest riding qualities to the car.

Valves.—The Nelson Valve Company, Wyndmoor, Philadelphia, Pa., is issuing its 1909 catalog in the form of a 220-page, cloth bound book, printed on heavy coated paper and arranged in a very attractive style. The catalog is confined exclusively to valves and accessories and covers the field very fully. For convenience in reference it is divided into three sections, the first being on bronze valves in all styles; the second on iron body and steel valves and the third on accessories and fittings. In each case the type of valve under discussion is shown by a full page illustration and a table is included giving complete general dimensions of the different sizes. All valves manufactured by this company are carefully tested and inspected and are fully guaranteed. Valves of all sizes and for all purposes will be found in this book, which includes a complete index.

Blue Print Papers.—Keuffel & Esser Co., Hoboken, N. J., is issuing a circular on the subject of blue print papers. This company manufactures a number of grades of blue print paper, each being specially adapted for certain printing conditions, and in this leaflet will be found details giving sizes and prices of each kind.

Railroad Hydraulic Tools.—Catalog No. 73 bearing the above title, has just been issued by the Watson-Stillman Company, of New York. This is a 120-page book describing a most complete line of hydraulic tools for steam and electric railway service, and includes a number of entirely new devices and machines. Among these are several new types of jacks; a series of hydro-pneumatic wheel presses, which are much quicker in operation than the older types; a motor driven forcing press of wide range; a new hydraulic coping machine and a hydraulic beam shear, both of which effect a large saving on work of this character. Illustrations have been liberally used throughout and specifications and prices are included with each machine.

"Joxyl."—An explanatory treatise is being issued by the American Joxyl Company, 30 Church St., New York City, which points out the application of this process for passenger car, station and similar uses. In using this process the surface of the panel, for instance of wood, either hard or soft, is first chemically treated, so as to open the pores, following which the design or color is applied with the result that it does not remain a coating on the surface but is transfused into the wood itself. Following this a chemical treatment is applied with the result that the pores of the wood are instantly closed far more tightly than is done by nature. The colors and designs are thus made permanent and the surface is rendered unusually hard and durable and capable of receiving the most brilliant polish. In other materials than wood the same results can be obtained by a slightly different process.

NOTES

Chicago Car Heating Co.—Roswell P. Cooley, mechanical inspector of the Pullman Company, has resigned to accept a position with the Chicago Car Heating Co.

Curtis & Curtis Co.—A decided improvement in business is reported by this company, which is now running its plant at Bridgeport, Conn., to full capacity in all departments. It is announced that export as well as domestic orders are very large.

The S. Obermayer Company.—The fire at the Cincinnati plant of this company Saturday night, September 11th, damaged the warehouse but did not damage the various manufacturing departments. There was no interruption to the business and orders are being filled with the usual promptness and dispatch.

Standard Coupler Co.—Charles R. Jenks has been appointed western sales manager of the above company with office at 1207 Fisher Bldg., Chicago. Mr. Jenks has been connected with the Pressed Steel Car Co. for the past seven years, and previous to that time was for eight years in the traffic department of the Pennsylvania Railroad Company.

Grip Nut Co.—L. H. Raymond, formerly master mechanic on the New York Central Lines, has accepted the position of eastern representative of the above company. It is also announced that the grip nuts manufactured by this company are ordered to be applied on 1,800 box cars recently ordered from the Pullman Company for the Northern Pacific Railroad.

Philadelphia Bourse.—With others the following concerns have recently placed exhibits and offices in the exhibition and selling department of the Philadelphia Bourse: Brown & Sharpe Mfg. Co., Tools; August Mietz, New York, Gas and Oil Engines; De La Vergne Machine Co., New York, Gas and Oil Engines, Refrigerating and Ice Making Machinery; and Trenton Engine Co., Trenton, N. J., Steam and Gas Engines. Some changes are being made in this department, which make it most attractive, and everything is being done to obtain the very best possible results for the exhibitors.

Western Electric Company.—The Philadelphia & Reading Railroad have followed the Pennsylvania and the Erie, as well as other large roads, in adopting a new device for the transmission of routine messages, which permits the use of the telegraph lines for telephone connection simultaneously with the use of the same lines for telegraph transmission. These devices and the apparatus have been furnished by the above company and seven telephone, as well as three intermediate telegraph stations have been equipped. The apparatus is not designed for the dispatching of trains but is entirely for the handling of local routine communications.

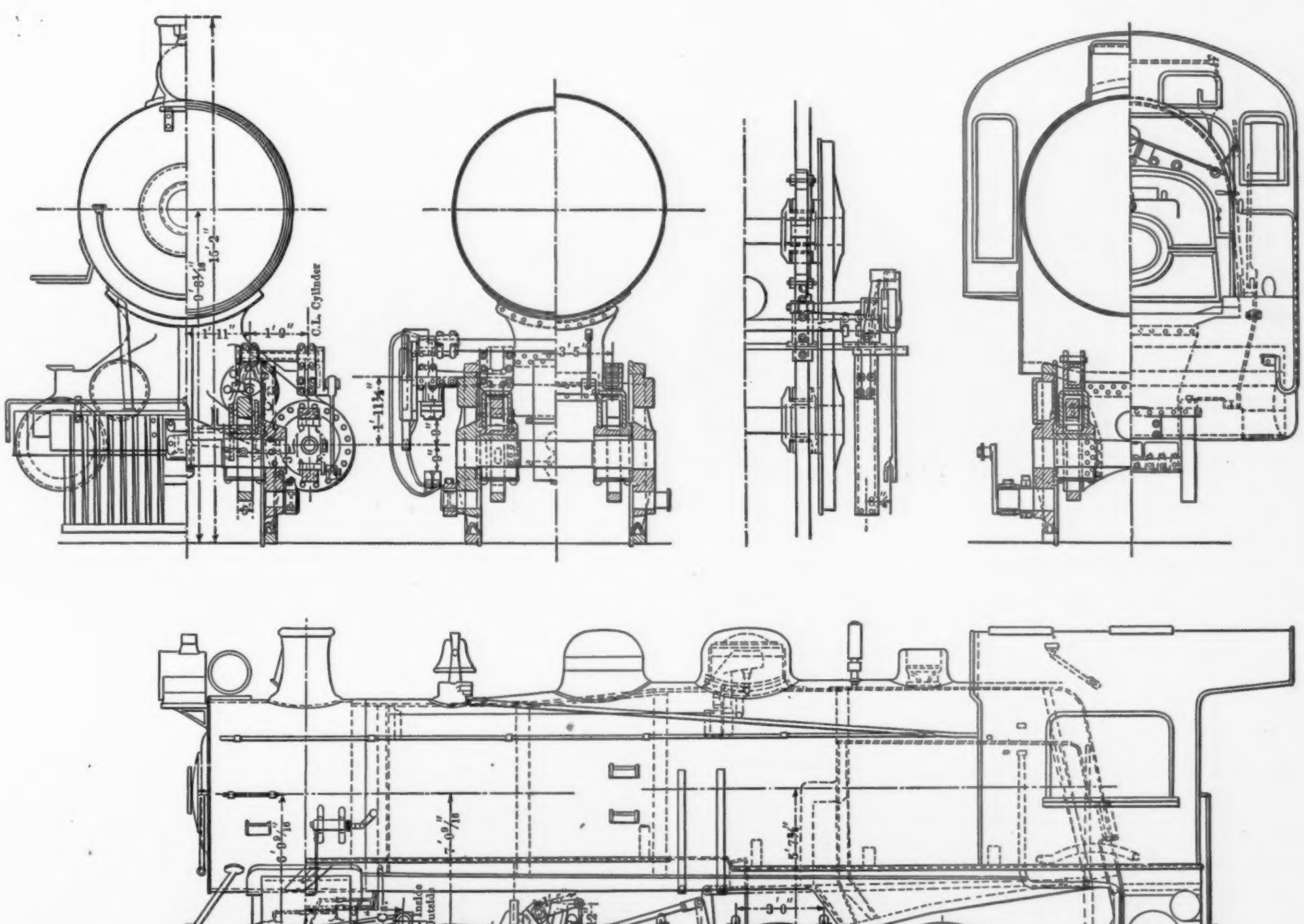
WANTED.

CONSOLIDATION LOCOMOTIVE WITH SUPERHEATER

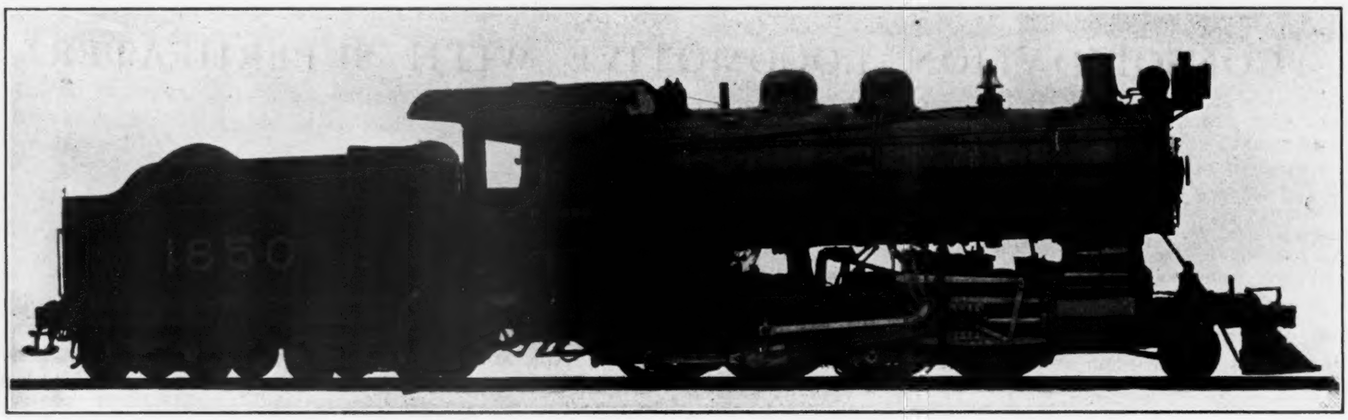
CANADIAN PACIFIC RAILWAY.

In the 1906 volume of this journal, more especially in the April and May numbers, will be found articles descriptive of the system of standardization of locomotive equipment, as well as a description of the standard locomotives and their parts, adopted by the Canadian Pacific Railway. In this classification the Class M4 is the standard consolidation locomotive and is, with a single exception, the most powerful class of locomotives on the road, being what is termed a 180 per cent. engine, the basis (100 per cent.) being 20,000 lbs. tractive effort at 80 per cent. of the boiler pressure. The locomotives of that class are 21 x 28 in. simple engines having 57 in. drivers and weighing 186,200 lbs., of which 163,700 lbs., or 87½ per cent., is on drivers. The boiler is of the extended wagon top type, 69 in. in diameter at the front end and carries a steam pressure of 200 lbs. All of these locomotives have superheaters and in some of the later ones the steam pressure is reduced to 180 lbs. and the cylinders enlarged to 22½ x 28 in.

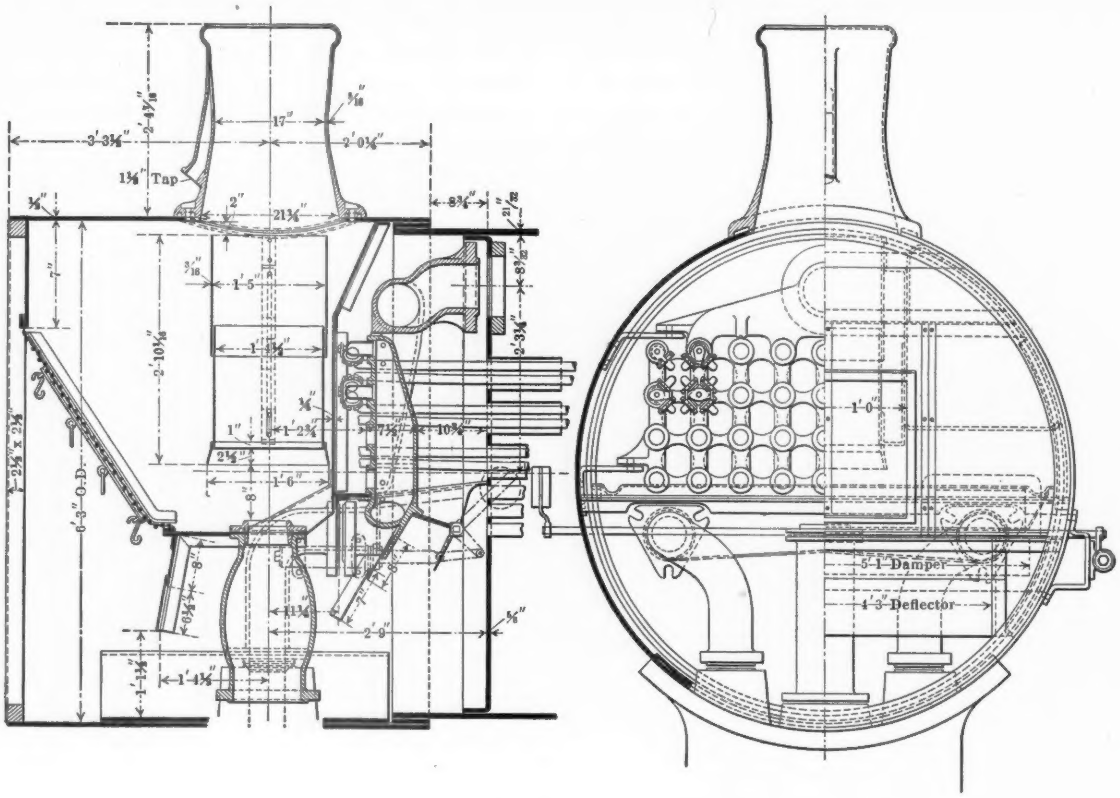
The traffic now demands a more powerful type of locomotive and an entirely new design of consolidation engine, which is known as class N3, has been developed. While, of course, a large number of the former standard parts are used in this design it is, in the main, an entirely new arrangement. It is a 210 per cent. engine and has a tractive effort of 42,500 lbs. The total weight is 220,000 lbs. and 195,000 lbs., or 88.6 per cent. is on drivers. The cylinders are very large, being 24 x 32 in., and a boiler pressure of 180 lbs. with a Vaughan-Horsey superheater, having 450 sq. ft. of heating surface, is employed. The drivers have been enlarged to 63 in. and the boiler has an evaporative heating surface of 2,811 sq. ft. as compared with 2,381 in the class M4. An examination of the ratios shows that while the



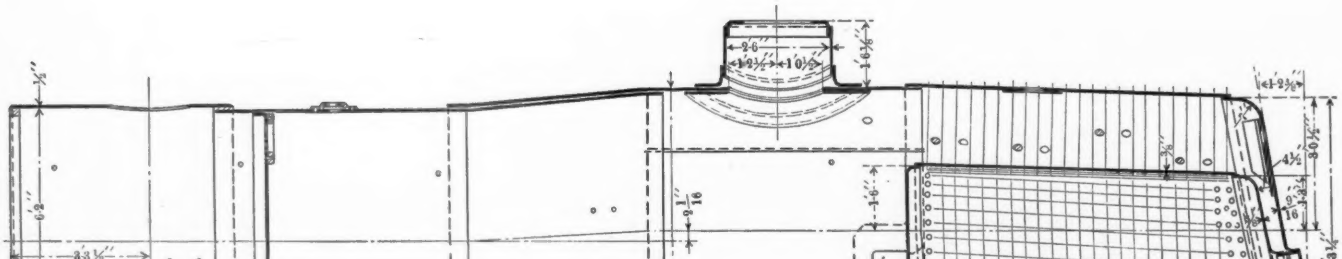
SIDE ELEVATION AND CROSS-SECTIONS OF CONSOLIDATION LOCOMOTIVE—CANADIAN PACIFIC RAILWAY.



CONSOLIDATION LOCOMOTIVE—CANADIAN PACIFIC RAILWAY.



SMOKE BOX AND SUPERHEATER ARRANGEMENT.



LONGITUDINAL SECTION THROUGH BOILER.

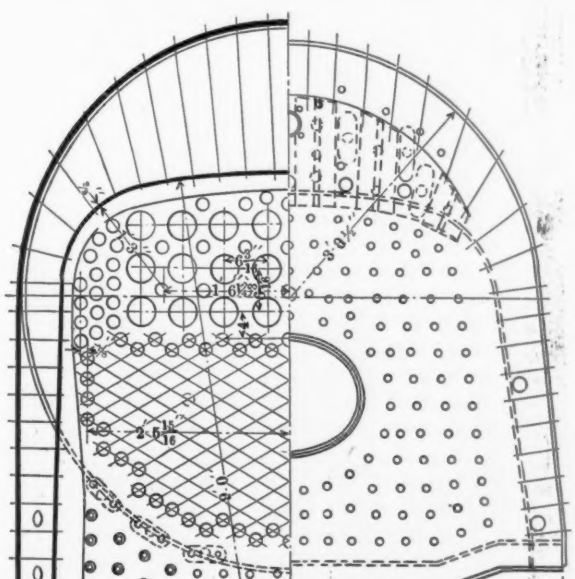
evaporative heating surface has kept pace with the increase in the weight of the locomotive, as compared with the class M4, the increase in the size of the drivers has affected the B D factor very materially, giving a figure of 1,003, as compared with 880. When the B D factor is determined by the use of an equivalent heating surface, the derivation of which will be explained later, it is found that it has a value of 815 as compared with 714 for the class M4.

In general the locomotive will be seen to be a normally conservative design arranged in many particulars to suit the special conditions under which it is to be operated. An electric headlight on a heavy freight locomotive is somewhat unusual, as is also the location of the air reservoir. The different parts of the locomotive will be considered separately, beginning with the boiler.

Boiler.—A radial stay, extended wagon top type of boiler having a firebox of large volume, with an inclined grate of 49 sq. ft. area, has been applied. Its largest diameter is 79 in. and the smallest 72 in. The throat is but 19¼ in. in depth and the level of the back mudring is slightly above the bottom of the barrel of the boiler, the grate inclining 20 in. in a length of 9 ft. 2¾ in.

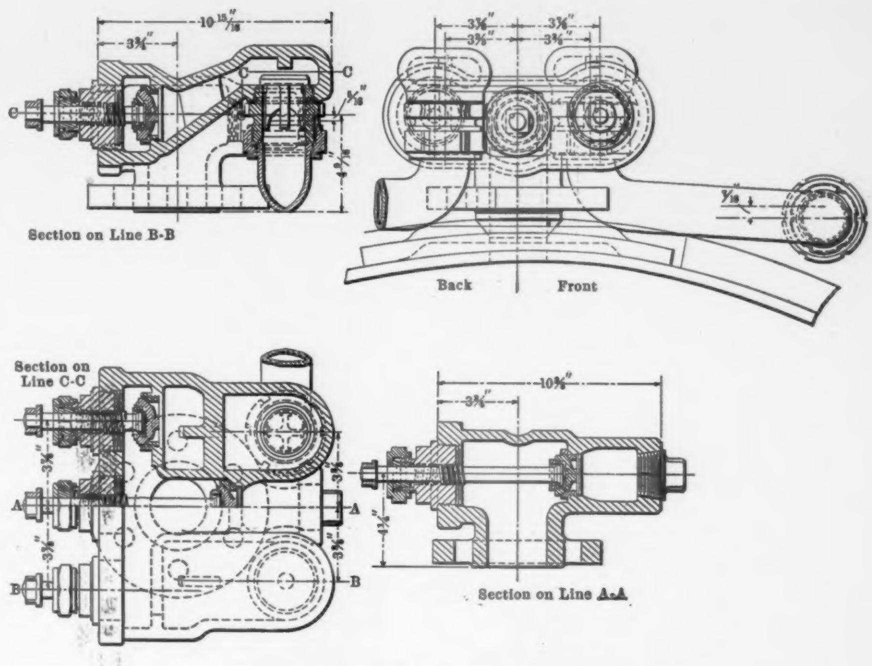
One of the most noticeable features is found in the use of curves of very large radii at the corners of the mudring, which are gradually decreased toward the top portion of the firebox. The side sheets are both slightly inclined inward from the mud-ring, which is 4½ in. wide on the side; the distance between the side sheets is increased by 1 in. at the turn of the crown. Both the side and crown sheets and the roof are in one piece.

The location of the tubes, which includes 24 5-in. and 272 2-in., the former being arranged in three rows of eight each for the



HALF SECTION THROUGH FIREBOX AND HALF END VIEW OF BOILER.

superheater elements, is shown in one of the illustrations. The heating surface of the fire tubes is 2,631 sq. ft., which, in connection with 180 sq. ft. in the firebox, gives 2,811 sq. ft. of evaporative heating surface. It has been found, however, that, in comparing a superheater engine with one using saturated steam, to get an equivalent heating surface in the latter it is necessary to multiply the superheating surface by 1.5, which should be added to the total heating surface of the engine as obtained in the ordinary manner. In this case this would show



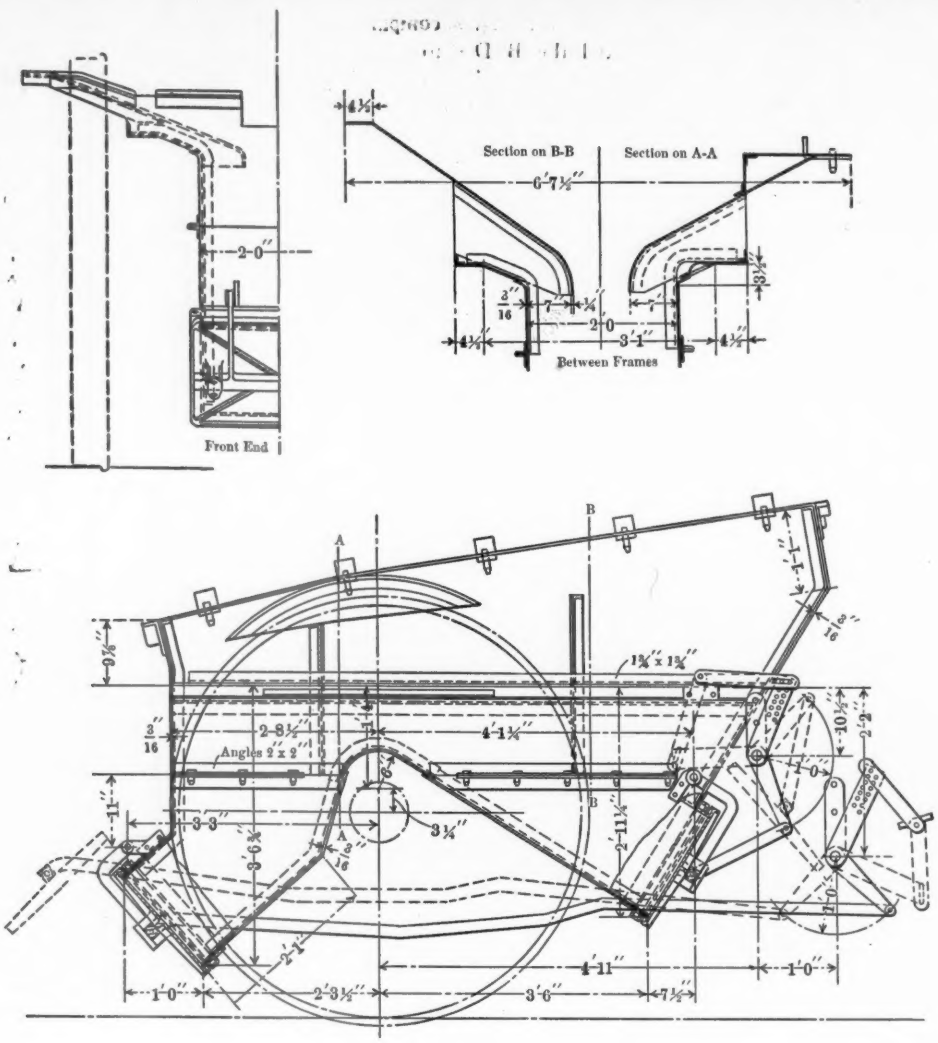
ARRANGEMENT OF CHECK VALVES AND SYPHON COCK.

that a boiler of the same capacity as the one applied, if it was not fitted with a superheater, would require 3,486 sq. ft. of heating surface, or a ratio of one square foot to 55.9 lbs. on drivers, which is certainly a guarantee of ample steam capacity.

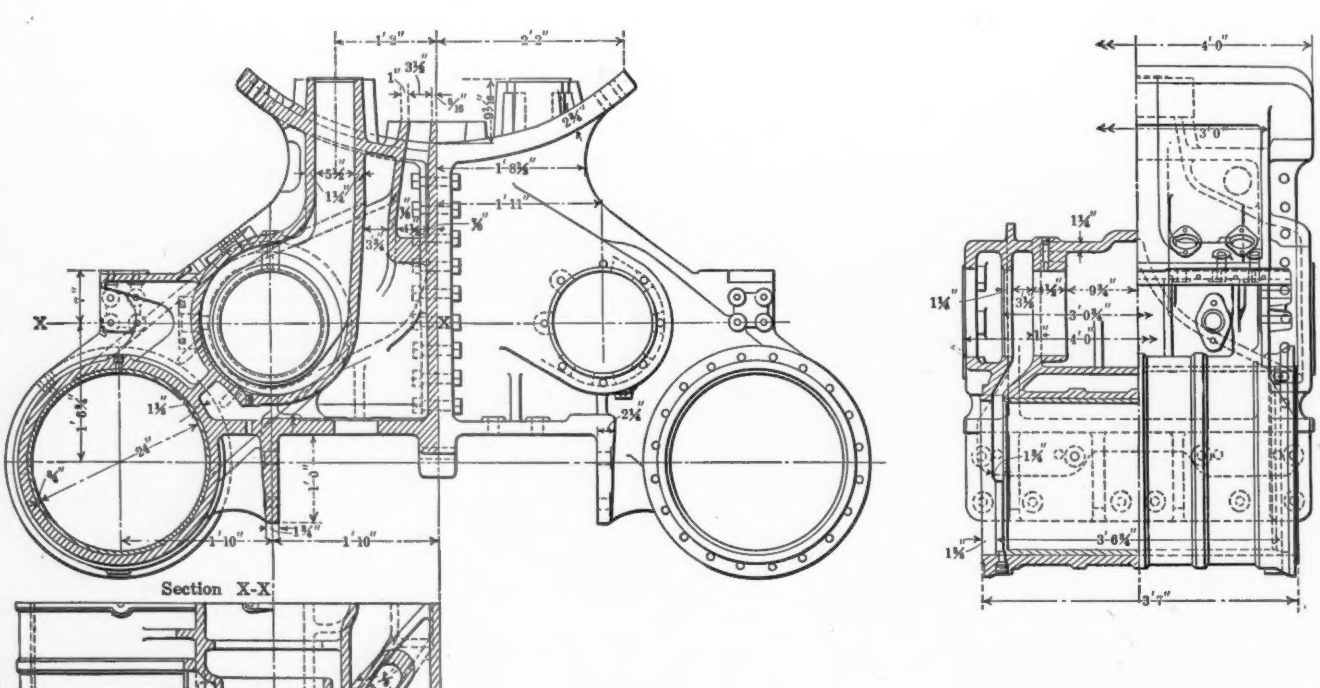
Front End Arrangement.—A section through the front end and superheater is given in one of the illustrations. This type of superheater was very fully described on page 41 of the February, 1906, issue of this journal, and has proven to be most satisfactory in every way, after a number of years of trial. It is now the standard type on the Canadian Pacific Railway, where a larger number of superheaters are in operation than on any American railroad. The introduction of the superheater requires the front tube sheet to be set back 2 ft. 9 in. from the center line of the stack and also the introduction of a special arrangement of diaphragm plates and a damper for cutting off the circulation to the large fire tubes when the engine is not using steam. The arrangement includes a comparatively low exhaust nozzle and long petticoat pipe in two sections. The stack has no internal extension. The presence of two adjustable deflectors admits of an accurate equalization of the draft. The petticoat pipe is arranged to be easily removed to permit access to the superheater elements behind it.

Check Valve.—The check valve is located on the top center line of the boiler, underneath the base of the bell stand. It consists of a double check arrangement, there being one check valve for either feed pipe, the passages from which are combined and enter the boiler through one opening. Each check valve passage is provided with a stop valve, which can be closed to permit the check to be reground when the boiler is under steam. A valve in the center of the casting closes the passage to a chamber in which there is a connection for a pipe or hose for either blowing down or filling up the boiler. All of these valves are provided with renewable seats. This arrangement of checks on top of the boiler gives a non-freezing discharge pipe from the injector to the checks and any leakage at the checks will drain back to the injector.

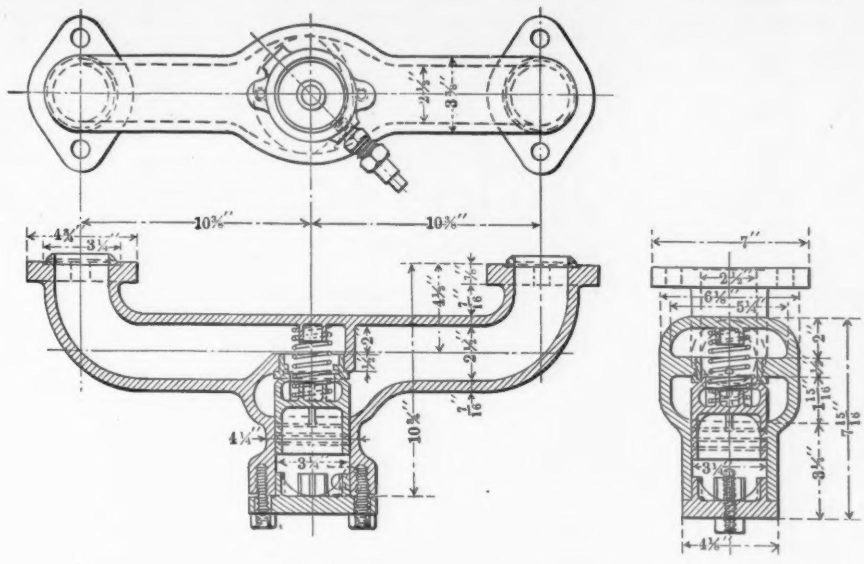
Ash Pans.—An exceptionally novel and interesting design of ash pan is used. It is of the self-clearing type, having two hoppers, and really consists of two separate parts, the hoppers and



UNIQUE DESIGN OF SELF-CLEANING ASH PAN.



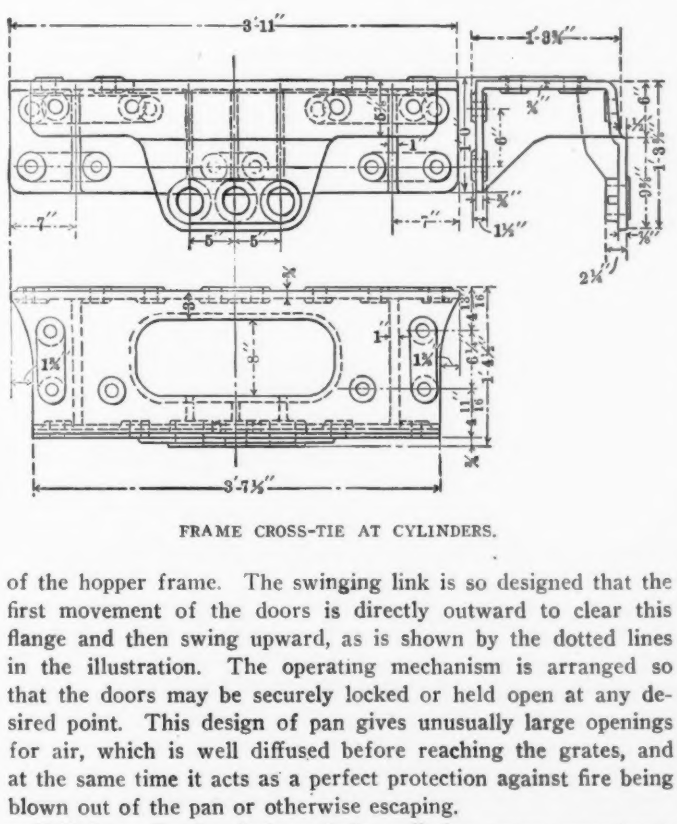
CYLINDERS OF THE CONSOLIDATION LOCOMOTIVE.



BY-PASS VALVE ARRANGEMENT.

their operating mechanism being secured to the locomotive frames, and deflector plates, forming the upper part of the pan, being secured to the mudring and extending down inside of the hopper section. There is an air inlet space 7 in. wide, in a horizontal direction, between the two sections. The arrangement and shape of this air space is well shown in the cross section of the pan. While the weight of the two parts is principally held by the frames and boiler respectively they are secured together and stiffened by the plates forming the end of the pan and by two intermediate ¼-in. stiffening plates secured to each through the medium of angles.

The doors closing the hopper openings are of the swinging link type, being arranged to fit over and seat upon an extension



FRAME CROSS-TIE AT CYLINDERS.

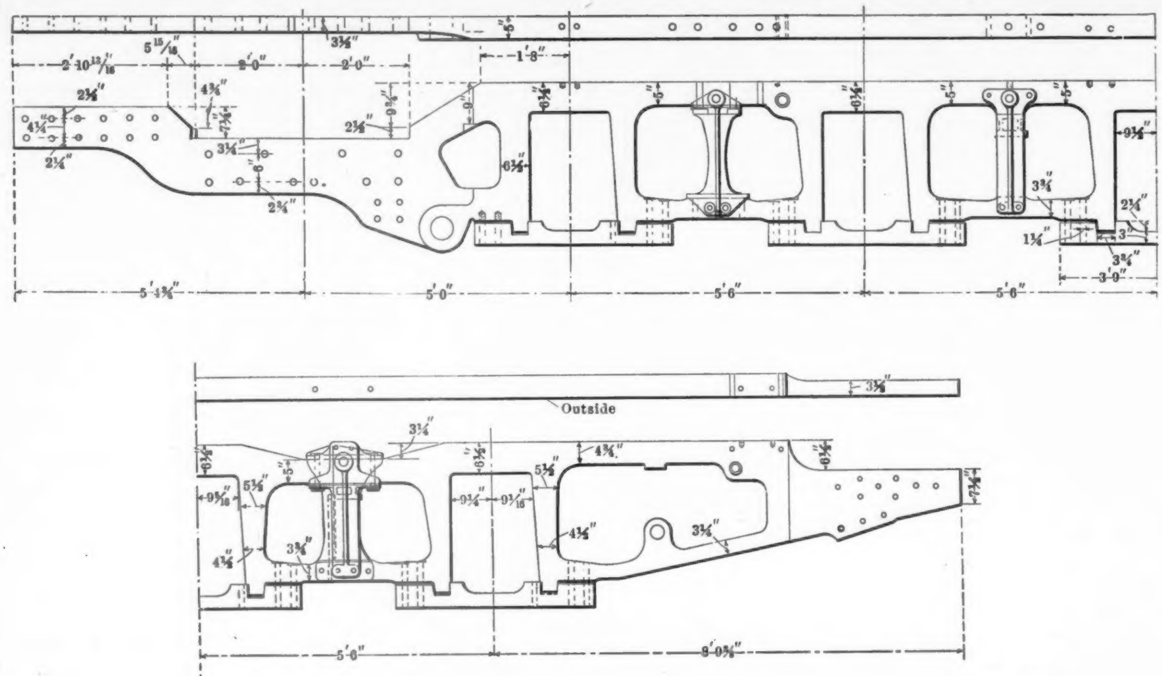
of the hopper frame. The swinging link is so designed that the first movement of the doors is directly outward to clear this flange and then swing upward, as is shown by the dotted lines in the illustration. The operating mechanism is arranged so that the doors may be securely locked or held open at any desired point. This design of pan gives unusually large openings for air, which is well diffused before reaching the grates, and at the same time it acts as a perfect protection against fire being blown out of the pan or otherwise escaping.

Cylinders.—In the design of the cylinders every opportunity has been taken for the reduction of weight where it could be done without sacrificing strength or steam economy. The 12-in. valve chambers have been set inside of the cylinders almost directly over the frames and in the line of the steam passage to the cylinders. This location of the valve has made necessary an alteration of the design of Walschaert valve gear previously standard on this road, which will be mentioned later. The cylinders have a ¾-in. bushing, and ports for the application of a by-pass valve arrangement somewhat similar to the Sheedy type, which has been in use on this road for some years, are provided. An excellent arrangement is noticed in connection with the fastening of the cylinders to the frames, consisting of two steel castings secured underneath the cylinder proper and inside of the frames, forming between them the bearing for the fulcrum pin of the front truck equalizer. This makes a solid mass across from frame to frame beneath the cylinders and puts no strain on the bolts fastening the cylinder flanges together at the center. It also gives a fulcrum pin bearing of great strength, which is entirely independent of the cylinder casting. The design of these cross-ties is shown in one of the illustrations.

A by-pass valve arrangement, as shown in the illustration, is fitted to the cylinders and covered by the cylinder jacket. The two openings in the cylinder casting are the terminations of passages from the steam ports and connect to the by-pass valve casting with ground joints. In the center of this casting is a valve with a renewable seat, which is held open by a coiled spring. The valve is closed by the pressure of steam in the chamber behind it, in which it has a steam tight fit. This chamber is connected by a small pipe to the center steam passage in the valve chamber, so that when the throttle is open the by-pass valve is closed and communication between the two ends of the cylinder is prevented. When steam is shut off, however, the valve is held open by the spring and air is permitted to freely circulate from one end of the cylinder to the other.

Valve Gear.—Because of the difference in the location of the valve chamber in this design the valve gear differs somewhat from the one illustrated on page 16 of the January, 1908, issue of this journal, although it is designed on the same general principles. Reference to that description will show that, in that case, the valve was located directly over the cylinder, the whole weight of the forward part of the gear being supported by a bracket, forming part of the back steam chest cover, carrying a rocker to which is secured the combination lever and a block working vertically in a crosshead fastened to the valve stem, which sets in guides, also forming part of the steam chest head. The idea of this arrangement is to relieve the valve stem of all stresses from the weight of the other parts of the valve gear.

In the present design the same idea has been followed by connecting the combination lever to the outer arm of a rock shaft, the inner arm of which carries a small crosshead working in guides, forming part of the valve stem. The valve stem itself is extended backward and carried in a guide secured on top of the frames. The rock shaft is supported by most substantial bearings; the outer one, of very rigid design, is secured to the



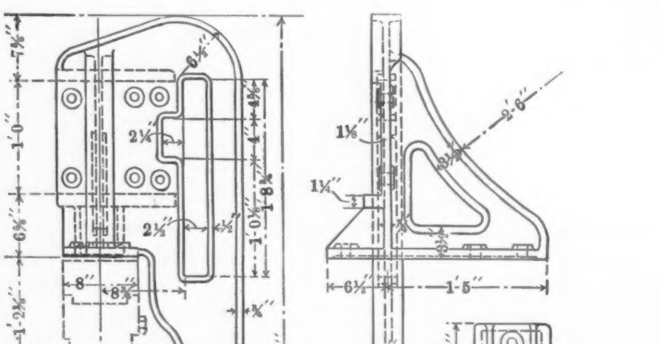
FRAME OF CONSOLIDATION LOCOMOTIVE.

cylinder casting directly above the cylinder and the inner one is part of the valve chamber head. The bearings are both inside the arms of the rocker. In this manner the valve stem is relieved of the duty of carrying the weight of any part of the gear and is held in perfect alignment. The other features of the valve gear are practically the same as was shown in the article above mentioned. The design and method of supporting the link is of particular interest.

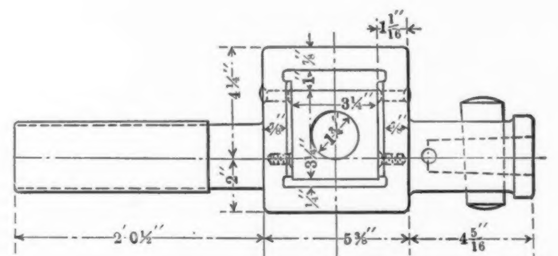
Guide Yoke.—The guide yoke is of the built-up type comprising a 1¾ x 12-in. wrought iron plate, supported across the frames by very substantial cast steel knees located in the rear of the yoke and including in the same casting the inner bearing for the link shaft. These knees are most securely bolted to the plate, having a lip over the top and a very liberal bearing and secure fastening to the top of the frames. At the outer end of the cross plate are secured large cast steel carriers for the guides, the details of which are shown in one of the drawings. These are of I-beam section throughout and include brackets for carrying the guides, the upper one being nearly 2 ft. in length and carrying the guide by three 1¼-in. bolts. These yokes were most carefully designed to obtain the required strength and rigidity with a minimum weight and are cut out for clearance of the radius bar. The plate is set in a recess in these castings and secured to each by six 1⅛-in. bolts

From the guide yoke are also carried the outer bearing of the link shaft and the bearings for the lift shaft, these being separate castings ot steel, which were specially designed to combine the maximum rigidity with minimum weight. They are carried on the back of the cross plate by four 1⅛-in. bolts. Each has a lip over the top of the plate and a bearing for the full depth of 12 in.

Frames.—One casting, 35 ft. 8⅛ in. long, forms each of the frames. The main section is 5 in. thick and has a depth of 6½ in. at the pedestal. The forward section passing below the cylinders, however, is but 3½ in. wide, the inside edge being in alignment with the main frame. The section below the cylinders is 12 in. in depth at the narrowest point. The pedestal binders are of the clip type, being held by two 1¼-in. bolts at either end. The design throughout is simple and straightforward, requiring comparatively few departures from straight line work on the slotter.



CAST STEEL CARRIERS FOR THE GUIDES.



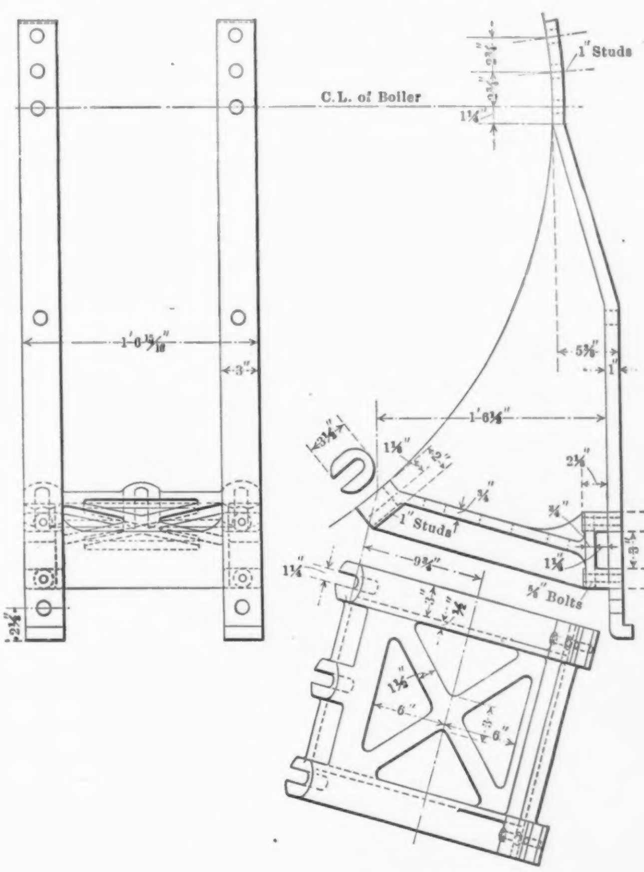
VALVE ROD EXTENSION.

Bumper Beam.—Three steel castings with a 15-in. channel form the bumper beam and center pin bearing. The casting between the frames, which forms the guide for the truck pin, is similar to that which was commonly used when cast iron was the only

material available. It is deeply ribbed and securely fastened between the frames, but has no connection to the cylinder casting. In addition to this there are two castings on the outside of the frames, of deeply ribbed section, forming the wings of the bumper beam. These three castings are secured together by a 15-in., 40-lb., channel, which forms a tension member in case of any cornering strains on the end of the bumper beam. This makes a very strong arrangement, but also one which, in case of accident, permits part of the beam to be replaced without disturbing the remainder. The frames are terminated 10¾ in. from the face of the beam, the castings being lipped over the ends of the frames. The whole beam is covered with a ¼-in. plate, which is cut away where necessary and has a hinged section on each side to permit the removal of the pistons.

Driving Boxes.—The driving boxes have brasses 14 in. in length, the axles being 9½ in. in diameter except the main, which is 10 in. The boxes are set 1 in. out of line with the center of the frames, toward the inside, the spring rigging being arranged to be central over the box. This gives a longer bearing area than would otherwise be possible and introduces no particular complications.

The spring rigging is of the customary type, having the front pair of wheels equalized with the front truck and the remaining three on either side being equalized together.



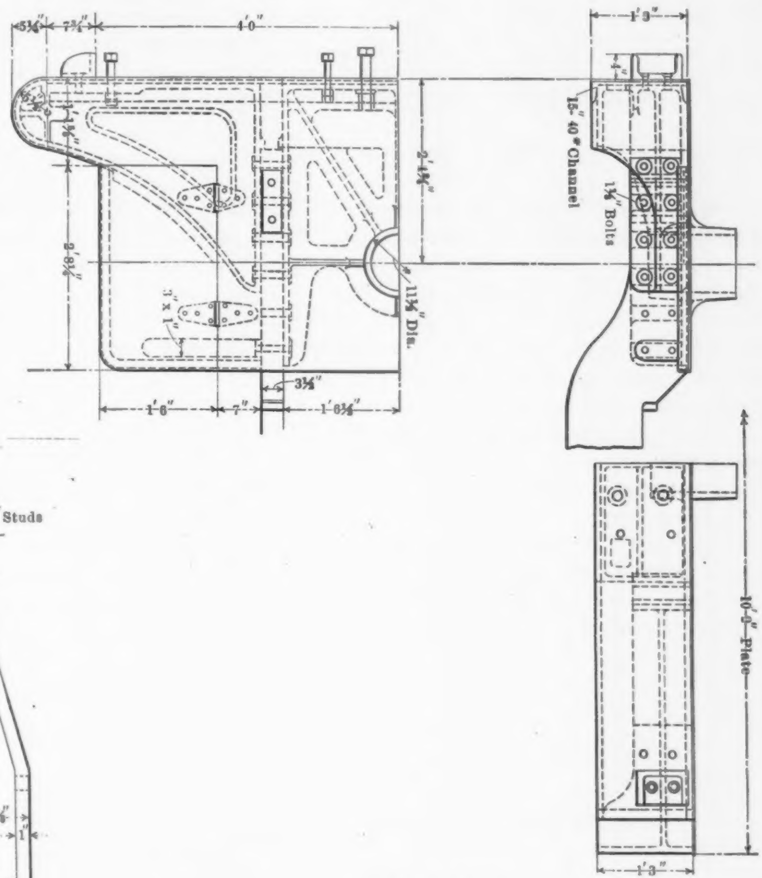
BRACKET FOR AIR PUMP.

Air Pump Bracket.—A new design of air pump bracket is found on this locomotive, which is considerably lighter and fully equal in strength to the designs commonly in use. It consists of two 1 x 3-in. wrought iron straps, each secured by three 1-in. studs to the boiler shell at the top, and held in position at the bottom by a cast iron bracket extending out from the boiler and secured to each of the straps by two ⅝-in. bolts. The air pump is bolted directly to the vertical hangers, which are lipped over on the bottom. The illustration clearly shows the details of this bracket.

The general dimensions, weights and ratios of this locomotive, which was designed in the mechanical engineer's office under the supervision of H. H. Vaughan, assistant to the vice-president, are as follows:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight and Passenger
Fuel	Bit. Coal
Tractive effort	44,750 lbs.
Weight in working order	220,000 lbs.
Weight on drivers	195,000 lbs.



BUMPER BEAM.

Weight on leading truck	25,000 lbs.
Weight of engine and tender in working order	354,000 lbs.
Wheel base, driving	16 ft. 6 in
Wheel base, total	25 ft. 5 in.
Wheel base, engine and tender	55 ft. 7⅞ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.36
Total weight ÷ tractive effort	4.92
Tractive effort × diam. drivers ÷ heating surface	1003.00
Total heating surface ÷ grate area	57.35
Firebox heating surface ÷ total heating surface	6.40
Weight on drivers ÷ total heating surface	69.4
Total weight ÷ total heating surface	78.3
Volume both cylinders, cu. ft	16.75
Total heating surface ÷ vol. cylinders	168.00
Grate area ÷ vol. cylinders	2.92

CYLINDERS.

Kind	Simple
Diameter and stroke	24 x 32

VALVES.

Kind	Piston
Diameter	12 in.
Greatest travel	6 in.
Outside lap	1 in.
Inside clearance	Line and line
Lead in full gear	¼ in.

WHEELS.

Driving, diameter over tires	63 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10 x 14 in.
Driving journals, others, diameter and length	9½ x 14 in.
Engine truck wheels, diameter	31 in.
Engine truck, journals	6 x 10 in.

BOILER.

Style	E. W. T.
Working pressure	180 lbs.
Outside diameter of first ring	72 in.
Firebox, length and width	101⅛ x 69¼ in.
Firebox plates, thickness, crown and sides	⅜, Tube ½, and Back ⅜ in.
Firebox, water space	F. 5, S. 4½, B. 3½ in.
Tubes, number and outside diameter	24—5 in.
Tubes, number and outside diameter	272—2 in.

Tubes, length	15 ft. 2¾ in.
Heating surface, tubes	2,631 sq. ft.
Heating surface, firebox	180 sq. ft.
Heating surface, total	2,811 sq. ft.
Superheater heating surface	450 sq. ft.
Grate area	49 sq. ft.
Smokestack, diameter	17 in.
Smokestack, height above rail	15 ft. 2 in.
Center of boiler above rail	9 ft. 8 1/16 in.

TENDER.

Weight	134,000 lbs.
Wheels, diameter	34 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	5,000 gals.
Coal capacity	10 tons

LOCOMOTIVE FIREBOX REPAIRS

CECIL LIGHTFOOT.

Among the most recent developments in the application of the oxy-acetylene blowpipe is its use in repairs to locomotive fireboxes. As a substitute for chain riveting or stud patching in the repair of cracks, the oxy-acetylene welding process is admirably adapted and it is now being employed by a number of railway companies for work of this kind with the greatest success. In cases of a simple or isolated crack, the defective part is first cut or drilled out and the surrounding surface cleaned; the cavity is then filled with a mild steel wire, such as Norway iron. For work of this nature, it is necessary that the sides of the cavity be in a thoroughly molten condition at the point where the welding is being done.

Oxy-acetylene welding must be regarded as a trade which can only be mastered by intelligent work and gradual development from simple to difficult jobs. Much depends not only on the intelligence and ability of the workman, but also on the use of blowpipes and apparatus of the best quality and of established reputation. It should be borne in mind, moreover, that notwithstanding the excellent results which are being daily obtained with this method of welding the process has its limitations. This is more particularly the case with overworked steel in an old furnace. This, as is well known, becomes highly brittle and it cannot be welded unless carefully annealed first. A large number or nests of cracks indicate this condition of the plate or show it to have been originally of bad quality. In such cases, it is desirable not to undertake welding repairs of any kind.

As an example of what is now being done, the following description of some recent repairs may be of interest:

A patch was welded on the outside end sheet of a firebox (Fig. 1). The damaged part of the plate was removed by cutting out one line of staybolts (8 in number), and the bolts in the mudring. A new piece of plate was cut and fitted, the staybolts being replaced; only two of the bolts in the mudring were replaced or just enough to hold the plate in position while welding. The old and the new plates were then welded together in 2 hours and 3 minutes, with a consumption of 59 cubic feet of oxygen, the weld being 51 in. long and ⅜ in. thick. The plates were not preheated, but the two bolts in the mudring were removed as soon as the weld was finished so as to release the patch from any strain due to contraction in the cooling of the weld. Including labor the total cost of welding in this patch was about $3.50.

A patch was welded on the inside side plate of the same firebox. The dimensions of this patch are shown in Fig. 2. In this case the patch was removed by the cutting blowpipe in 12 minutes (The thickness of the plate was 5/16 inch and total length of cut 7 ft. 2 in.), with a consumption of 11 cubic feet of oxygen. The new patch was prepared and held in position by means of the staybolts marked with an X, the other staybolts being left out until after the weld was finished. To allow for contraction, the plate was dished to the extent of ⅝ in., so that as the weld cooled off and contracted the plate straightened itself out. This was helped a little by having three loose bolts placed through the patch and outer sheet where the staybolts had been removed, these bolts being tightened up as the weld cooled off. After the weld was completed, the plate was found to be quite flat. The remaining staybolts were then screwed into place. The time for this weld was 2 hours and 17 minutes—oxygen consumption 50 cubic feet. Including labor the total cost of making the patch was about $3.75, including the cost of cutting out.

A cast steel bolster, cracked across the top section, was repaired. This crack was ⅝ in. deep and 11½ in. long. The bolster was preheated to a dull red heat, after the crack had been chipped out to an angle of 90 degrees, and was then welded up in 23 minutes with a consumption of 25 cubic feet of oxygen. The position of this crack is shown in Fig. 3. Total cost about $1.00.

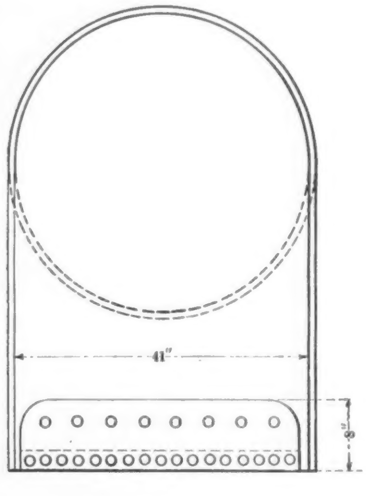


FIG. 1

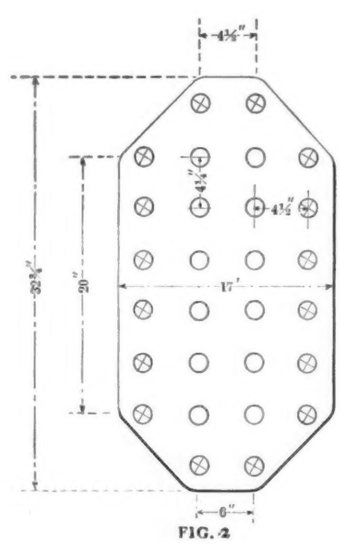


FIG. 2

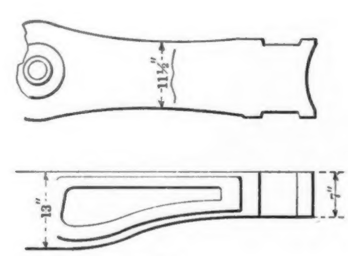


FIG. 3

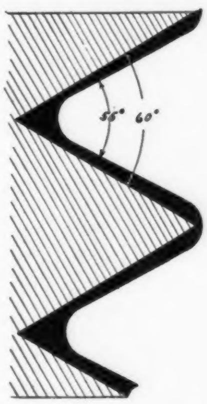
The bottom half of a smokebox of an engine, which had been run into by some freight cars, was removed. The plate and the ring were doubled back towards the front flue sheet. The ring, 2¼ x 2¼ in., was first cut in two places in 4½ minutes, with a consumption of 5 cubic feet of oxygen. The rest of the damaged plate, ⅜ in. thick, was cut out in pieces, the total length of cut being 8 ft. 1 in., of which 12¼ in. was double plate. The actual cutting time was 32½ minutes with a consumption of 47 cubic feet of oxygen. Total cost about $2.25.

In 1908 there were 1,252 street railways in the United States owning 89,216 cars and with a capital stock of $2,444,892,057, or an increase of $193,466,175 over 1907. The mileage was 40,247 as compared to 38,812 for 1907.

TEST OF STAYBOLT THREADS.

C. J. MORRISON.

The V thread was generally used on staybolts for many years, but recently the Whitworth thread has been attracting considerable attention. The difference between the Whitworth and the V threads is that with the former the threads at the root and the tap are finished to a slight radius, as is shown in the illustration, consequently the depth of the thread is less and the minimum diameter of the bolt is proportionately increased; also the angle of the Whitworth thread is 55 degrees, while that of the V thread is 60 degrees. The illustration shows a section



ILLUSTRATING DIFFERENCE BETWEEN V AND WHITWORTH THREADS.

through one side of a hole tapped out with Whitworth and V threads, the additional metal tapped out for the V thread being indicated by the heavy black portion.

In order to ascertain the relative strength and life of staybolts with the two types of threads careful tests were made, and the following results obtained:

BOILER STAYBOLT TEST.

Thread.	Dia. of bolt.	Area in inches.	Breaking strain in lbs.	Strain per sq. in.	Original length.	Per cent. of elongation in length of section.
Sharp "V"	.880	.608	32, 1	52,870	8″	20.5
	.881	.610	32,910	53,960	8″	15.7
	.879	.607	31,140	51,310	8″	19.
Average.....	....	....	32,063	52,713	8″	18.4
Whitworth	.882	.611	33,060	54,120	8″	27.5
	.889	.621	33,040	53.210	8″	27.75
	.887	.618	33,080	53 540	8″	27.25
Average.....	....	....	33,060	53,623	8″	27.50

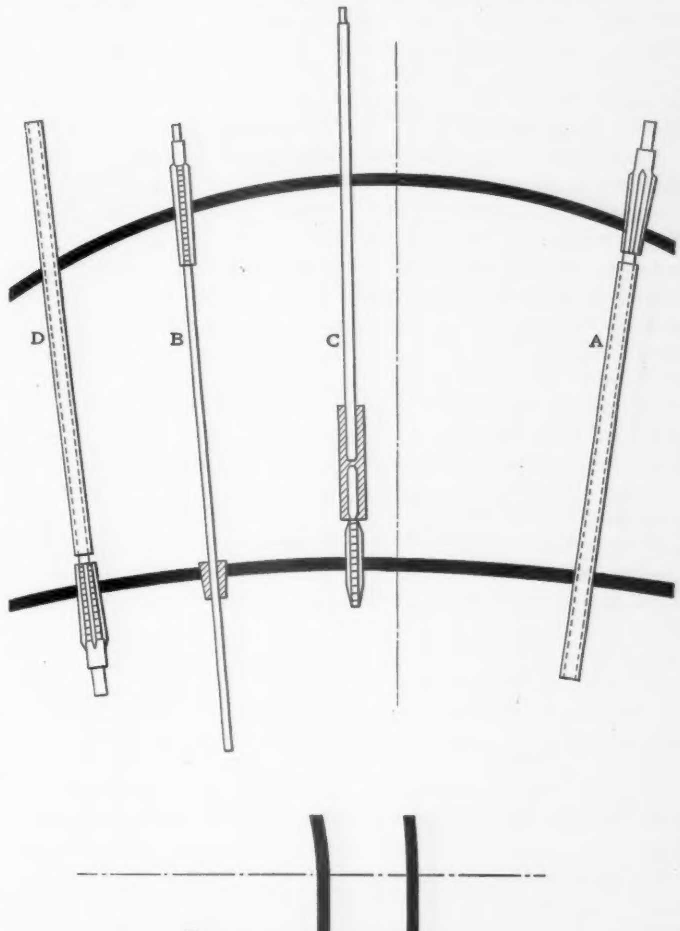
Vibration and bending tests were also conducted. In the vibration test, each bolt was screwed and riveted in a half-inch steel sheet in the same manner as staybolts are fastened in boilers. Each bolt was given a vibration of 3/8-inch; the average number of vibrations withstood by the V thread was 1485, while the average for the Whitworth was 3437. In the second series of tests each bolt was given 10,500 vibrations through 3/16 inch and then vibrated through 3/8 inch to destruction. The V threads averaged only 791 vibrations, while the Whitworth failed at 1932. One very noticeable feature of the tests was that the Whitworth thread bolts hold much tighter in the sheet than the V thread and also showed no tendency to cut into the sheet. Bending tests were also made, and in these the V thread failed when bent over a 3-inch circle, while the Whitworth withstood a bend over a 2-inch circle, but failed at 1 7/8 inch.

These tests show the theoretical superiority of the Whitworth thread, while the practical superiority has been demonstrated by the great decrease in broken staybolts on several roads which have adopted the Whitworth thread as standard.

After the adoption of a standard thread, it became necessary to devise a cheap and accurate method of tapping. Many contend that taps and staybolts with continuous threads are necessary, but practical demonstrations have shown the weakness of their arguments. It is a very easy matter to get threads 1/24 out of being continuous, which is the worst they could possibly be when not continuous. It is also exceedingly difficult to get the taps for long radial staybolt work continuous. If the tap is out .008 inch in hardening, which often occurs in a tap of that length, and the lead screw on the lathe is out the same amount, it is readily seen that the threads in the wagon top and crown sheet, after the holes have been tapped and the stays screwed in, are no more liable to be in line than had the holes been tapped with separate taps. A simple, cheap and accurate method of tapping these holes is shown in the illustration, and explained as follows:

A shows the reamer which is used for reaming the outside sheet.

B is a spindle tap in position tapping outside hole. The practice is to provide the boilermaker with two sets of taps. One



TAPPING HOLES IN A LOCOMOTIVE BOILER.

tap is run through the hole, and while a boy inside the boiler passes the tap out, the boilermaker starts in another hole.

C shows the extension socket which runs the same tap through the crown sheet.

D is the taper tap with which the hole in the crown sheet is finished.

E is regular side sheet staybolt tap.

This method has been in use for several years and has proved to be very satisfactory.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, secretary of this association, advises that the annual convention will be held at the Planters' Hotel, St. Louis, Mo., on May 16, 17 and 18, 1910.

DOUBLE OPEN DIAGONAL TRUSS FOR STEEL PASSENGER CARS.

ON FOUR POINTS OF SUPPORT, AND WITH EQUAL OVERHANGING ENDS.

ANALYTICAL AND GRAPHICAL ANALYSIS.

ARTHUR E. HEFFELFINGER.*

Believing that this detailed analysis will be found to be of greater value to the designer of steel passenger equipment, I have selected a common form of truss for a sixty-foot baggage car (having two doors in each side, and double body bolsters) as a good practical example.

It is obvious that the same solution is applicable to passenger cars with center doors, etc.; also that the principle involved is distinct from that employed in steel frame box car design where the bending moments in the top and bottom chords are resisted by some other continuous members, mainly the center sills, through cross-bearers.

The present designing of passenger equipment is so largely governed by the demand for a decreasing dead load per unit or passenger, also, greater facilities for exit, that, in the first place, increased length of structure is required, and secondly, larger and more openings in the side of car. The problem, then, becomes more involved, and with it there seems to come more or less conjecture as to the most economical method of distributing the stresses around the open panels or doors. Some engineers advocate side sills of uniform strength; others, a very complex system of bracing around the door, and still others remain loyal to the old truss-rod system. The last would seem rather superfluous when applied to a steel structure, except, perhaps, as a means to approximate a factor of safety against the uncertain stresses set up by oscillation.

Of course, these various systems depend more or less arbitrarily on the viewpoint, which is logical enough, when one considers how largely car construction is governed by practical considerations.

It is obvious, then, that the following analysis can only be of value as a demonstration of the solution of a simple, practical and economical system, of which all the process, except the several open panels, is past history. But, in order to enhance the value of this analysis to the busy designer each step of the process will be given, thereby understandingly facilitating its application to more complex systems, as well as simpler problems.

The conditions assumed in this case are: A sixty-foot baggage car, having two 6′—0″ door openings in each side, double body bolsters, and carrying a total load (dead and live) of 120,000 lbs., or 60,000 lbs. per truss.

Figure 1 shows approximate panel spacing and panel loads at apex points, which are symmetrical about the center of truss, and $R_1 + R_2 = \frac{60,000}{2} = 30,000$ lbs. But, since, resultant of R_1 and R_2 is half way between them, $R_2 = R_1 = \frac{30,000}{2} = 15,000$ lbs. This point is exceedingly important, and the truth of the assertion can be mathematically determined with ease.

ANALYTICAL SOLUTION.

Figure 1 shows truss and loads.

Natural tan of angle $a = \frac{7.54}{5} = 1.508$, $\therefore a = 56° 27' 0''$ nearly.

Natural sin. $a = .8334$ and natural cos. $a = .5527$.

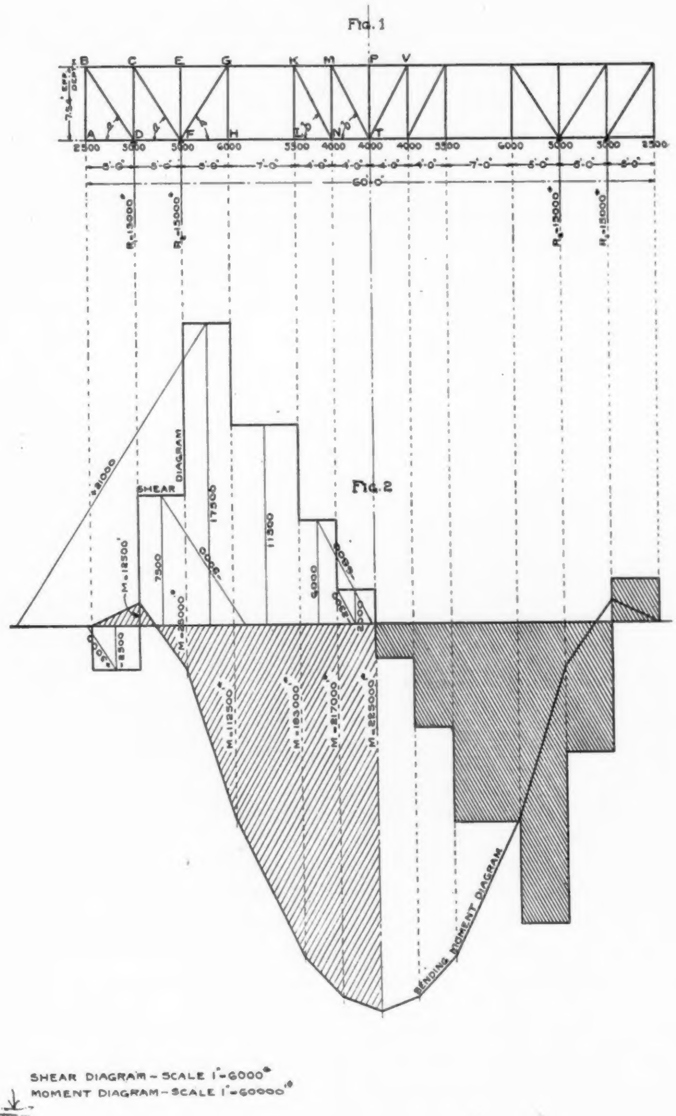
Natural tan. of angle $b = \frac{7.54}{4} = 1.885$, $\therefore b = 62° 3' 0''$ nearly.

Natural sin. $b = .8834$ and natural cos. $b = .4687$.

Stress in TP = zero, as MV must not be put in tension; ½ of the 4,000 lbs. at T passes up TM, and the other half up TV. $\therefore$ tension in $MT = \frac{2.000}{\sin b} = \frac{2,000}{.8834} = 2,300$ lbs.

At M the tension in MT is resolved into 2,000 lbs. vertical component in MN, and a horizontal component in MP. $\therefore$ compression in MN = 2,000 lbs., and compression in $MP = 2,300 \times \cos b = 2,300 \times .4687 = 1,100$ lbs.

At N, $2,000 + 4,000 = 6,000$ lbs. vertical load is resolved into tension in NK and tension in NT. $\therefore$ tension in $NK = \frac{6,000}{\sin b}$



$\frac{6,000}{.8834} = 6,800$ lbs., and tension in $NT = \frac{6,000}{\tan b} = \frac{6,000}{1,885} = 3,200$ lbs.

At K, the 6,800 lbs. tension in NK is resolved into a vertical and a horizontal component. The horizontal component produces compression in KMP. $\therefore$ compression in KMP = 3,200 lbs., and vertical component at K = 6,000 lbs.

Now, this vertical component at K = 6.000 lbs., and the load

* Designing Engineer, 227 N. Broome St., Wilmington, Del.

at L = 5,500 lbs., or a total vertical load = 11,500 lbs. must be carried over to GH. Because there is no diagonal in this panel, this shear of 11,500 lbs. must be carried over as transverse shear in GK and HL.

Figuring from the center of the girder over to L, we find a downward shear at L = 11,500 lbs.

Figuring from the end A, of the girder, over to H, we find an upward shear at H = 11,500 lbs.

These upward and downward shears form a couple, which produces a bending moment = 11,500 lbs. × 7′—0″ = 80,500′ lbs. One-half of this moment = $\frac{80,500}{2}$ = 40,250′ lbs., is carried by GK, and one-half by HL. No direct chord stresses result from this 11,500 lbs. shear passing over GK and HL; the stresses produced are a shearing and a bending stress only.

So far the chord stresses have been confined to KMP and NT.

Let GK and HL each carry ½ of 11,500 = 5,750 lbs., then 6,000 lbs., the vertical component at K, — 5,750 lbs., the amount carried as shear by GK, leaves 250 lbs., which passes from K, down KL to L as compression. Therefore 5,750 lbs. travels along KG to G as shear, and 250 + 5,500 at L = 5,750 lbs., travels along LH to H as shear. Therefore 5,750 + 6,000 at H = 11,750 lbs., travels from H up to G, producing tension in HG = 11,750 lbs.

At G, the 11,750 lbs. tension in GH and the 5,750 lbs. vertical shear brought over from K, or a total vertical load of 17,500 lbs., is resolved into compression in FG, and compression in GKMP. Therefore compression in GKMP = $\frac{17,500}{\tan a} = \frac{17,500}{1.508}$ = 11,600 lbs., and compression in FG = $\frac{17,500}{\sin a} = \frac{17,500}{.8334}$ = 21,000 lbs.

Since CG cannot take a transverse thrust or pull at E, the stress in FE = zero.

Therefore at F, the compression in FG is resolved into a vertical component acting downward at F, and a horizontal component producing tension in FHLNT.

∴ vertical pressure at F = 17,500 lbs. = vertical component of FG, and tension in FHLNT = 21,000 × cos a = 21,000 × .5527 = 11,600 lbs.

17,500 lbs. vertical pressure at F from FG, + 5,000 lbs. load at F = 22,500 lbs. total load at F. 22,500 lbs. — 15,000 lbs. upward reaction at F, = 7,500 lbs. excess downward pressure which must be carried up FC and down CD to D. Therefore at F, the vertical load of 7,500 lbs. is resolved into tension in CF and tension in FHLNT. ∴ tension in FC = $\frac{7,500}{\sin} = \frac{7,500}{.8334}$ = 9,000 lbs., and tension in FHLNT = $\frac{7,500}{\tan a} = \frac{7,500}{1.508}$ = 5,000 lbs. At C, the tension in FC is resolved into a horizontal component producing compression in CEGKMP, and a vertical component producing compression in DC.

∴ compression in CEGKMP = 9,000 × cos a = 9,000 × .5527 = 5,000 lbs., and compression in DC = 7,500 lbs. = vertical component of FC.

Load at A, 2,500 lbs., passes up AB as tension, and down BD as compression, to D.

∴ tension in AB = 2,500 lbs.

At B, tension in AB is resolved into tension in BCEGKMP, and compression in BD. ∴ tension in BCEGKMP = $\frac{2,500}{\tan a} = \frac{2,500}{1.508}$ = 1,700 lbs., and compression in BD = $\frac{2,500}{\sin a} = \frac{2,500}{.8334}$ = 3,000 lbs.

At D, the vertical component of BD = 2,500 lbs. = downward pressure at D, and the horizontal component of BD = 1,700 lbs. = compression in DFHLNT. No stress in AD.

Finally: 2,500 lbs. vertical pressure at D from BD, + 7,500 lbs. compression in DC at D, + 5,000 lbs. load at D, = 15,000 lbs. total downward vertical pressure at D; minus 15,000 lbs. upward reaction at D = zero, ∴ balances.

Total compression in MP = 1,100 + 3,200 + 11,600 + 5,000 — 1,700 = 19,200 lbs.

Total compression in KM = 3,200 + 11,600 + 5,000 — 1,700 = 18,100 lbs.

Total compression in GK = 11,600 + 5,000 — 1,700 = 14,900 lbs.

Total compression in CG = 5,000 — 1,700 = 3,300 lbs.

Total tension in BC = 1,700 lbs.

Total tension in NT = 3,200 + 11,600 + 5,000 — 1,700 = 18,100 lbs.

Total tension in FHLN = 11,600 + 5,000 — 1,700 = 14,900 lbs.

Total compression in DF = 1,700 lbs.

RECAPITULATION

Member	Stress	Member	Stress
BC	—1700	AB	—2500
CE	+3300	BD	+3000
EG	+3300	DC	+7500
*GK	+14900	CF	—9000
KM	+18100	FE	0000
MP=MV	+19200	FG	+21000
AD	0000	GH	—11750
DF	+1700	LK	+250
FH	—14900	KN	—6800
*HL	—14900	NM	+2000
LN	—14900	MT	—2300
NT	—18100	TP	0000

* These two members also have each 5,750 lbs. shear, and 40,250 ft. lbs. bending moment.

These stresses can also be checked by constructing the shear and bending moment diagrams, as shown in Fig. 2.

In panel NT there is a shear = 2,000 lbs., which resolved in the direction TM, gives a tension = 2,300 lbs. in TM. Then the 2,000 lbs. shear travels down MN as compression.

In panel LN there is a shear = 6,000 lbs., which gives 6,800 lbs. tension in KN and 6,000 lbs. vertical component at K.

In panel HL there is a shear = 11,500 lbs. Because there is no diagonal, half of this shear = 5,750 lbs. will have to pass from K to G as transverse shear in GK, and half will have to pass from L to H as transverse shear in HL. ∴ 6,000 lbs. vertical component at K, minus 5,750 lbs. carried from K to G as shear, leaves 250 lbs. which passes down KL to L, producing 250 lbs. compression in KL.

Also, 250 + 5,500 = 5,750 lbs. at L, passes from L to H as transverse shear in HL, and 5,750 lbs. at H plus 6,000 lbs. load at H = 11,750 lbs., which passes up HG as tension. 11,750 lbs. tension in HG plus 5,750 lbs. shear in GK = 17,500 lbs. at G.

In panel FH, there is a shear = 17,500 lbs., which produces 21,000 lbs. compression in FG.

In panel DF, there is a shear = 7,500 lbs., which produces 9,000 lbs. tension in CF and 7,500 lbs. compression in CD.

In panel AD there is a shear = 2,500 lbs., which produces 3,000 lbs. compression in BD, and 2,500 lbs. tension in AB.

No stress in AD, EF, and PT.

At D, we have $\frac{12,500' \text{ lbs.}}{7.54'}$ = 1,700 lbs. tension in BC, and 1,700 lbs. compression in DF.

At F, we have $\frac{25,000' \text{ lb.}}{7.54'}$ = 3,300 lbs. compression in CE and EG.

At H, we have $\frac{112,500' \text{ lbs.}}{7.54'}$ = 14,900 lbs. compression in GK, and tension in FH, HL and LN.

Between H and L we have a bending moment = 11,500 lbs. × 7′ = 80,500′ lbs. Because there is no diagonal in panel HL, this bending moment cannot be carried by either the chords or web members of the truss as direct stress. It must therefore be carried by either HL or GK, or both, as a bending stress.

This means that from H to T, this amount of bending moment, 80,500′ lbs., has no effect upon the direct stresses in the members of the truss between H and T. It must therefore be subtracted from the bending moments between H and T, to get the direct stresses in the members between H and T.

At L, we have $\frac{193,000' \text{ lbs.} - 80,500' \text{ lbs.}}{7.54'} = \frac{112,500' \text{ lbs.}}{7.54'}$ = 14,900 lbs. compression in GK and tension in LN, the same as was found by considering the bending moment at H.

At N, we have $\frac{217,000' \text{ lbs.} - 80,500' \text{ lbs.}}{7.54'} = \frac{136,500' \text{ lbs}}{7.54'}$ = 18,100 lbs. compression in KM and tension in NT.

At T, we have $\frac{225,000' \text{ lbs.} - 80,500' \text{ lbs}}{7.54'} = \frac{144,500' \text{ lbs.}}{7.54'}$ = 19,200 lbs. compression in MP.

We therefore see that the stresses, as found from the shear

and bending moment diagrams, check those found in the analytical solution.

GRAPHICAL ANALYSIS.

The structure being symmetrical about the center, lay out half the truss, as shown in Fig. 3.

Then, at points of support, 15,000 lbs. upward reaction — 5,000 lbs. downward load = 10,000 lbs. net upward reaction.

$\frac{ST}{2} = 2{,}000 + RS = 4{,}000 + QR = 5{,}500 = 11{,}500$ lbs. total vertical load to be carried across panel without a diagonal. This can be done by WG and GQ each carrying $= 5{,}750$ lbs. as a transverse shear.

This 5,750 lbs. downward shear at the right end of WG and GQ, and 5,750 lbs. upward shear at their left hand ends, form couples whose moments (5,750 lbs. × 7′ = 40,250′ lbs. each) tend to distort the panel with no diagonal.

This distortion is prevented by the moments of resistance of WG and GQ, which balance the moments of these couples.

We must therefore supply an imaginary downward force = 5,750 lbs. at left hand ends of WG and GQ, and an imaginary upward force = 5,750 lbs. at right hand ends of WG and GQ, to form couples equivalent to the moments of resistance of WG

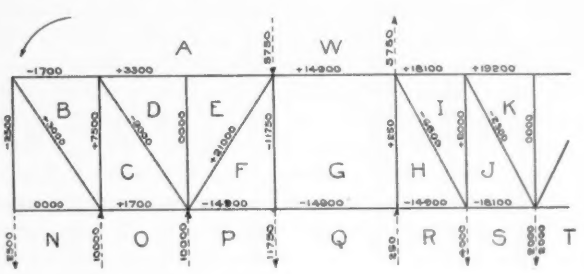


FIG. 3

APPLICATION.

In designing a truss to meet these stresses, it is a simple matter to select the members and make their connections,—up to the open panels or doors.

Then, referring to Fig. 5, which shows a practical enough design of construction about the open panels, to meet the stresses here, which are, a bending moment = 40,250′ lbs. at G, K, H and L. Also, 5,750 lbs. shear from G to K and from H to L.

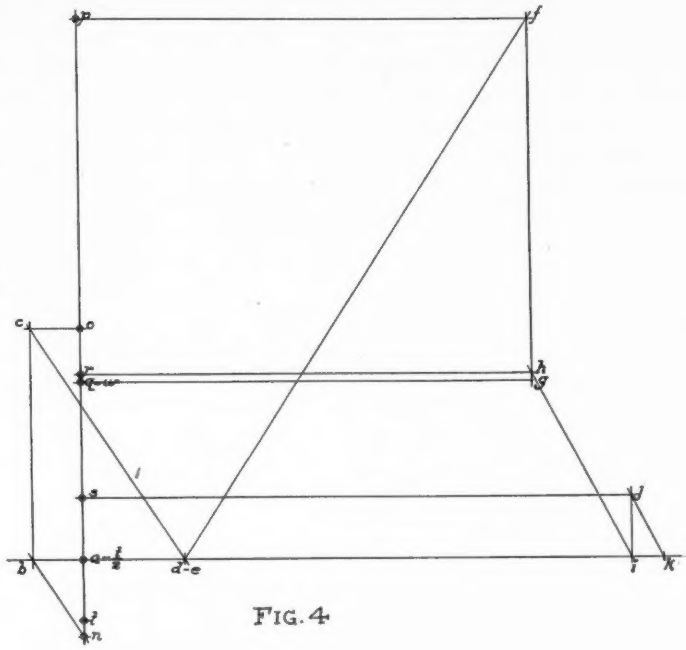


FIG. 4

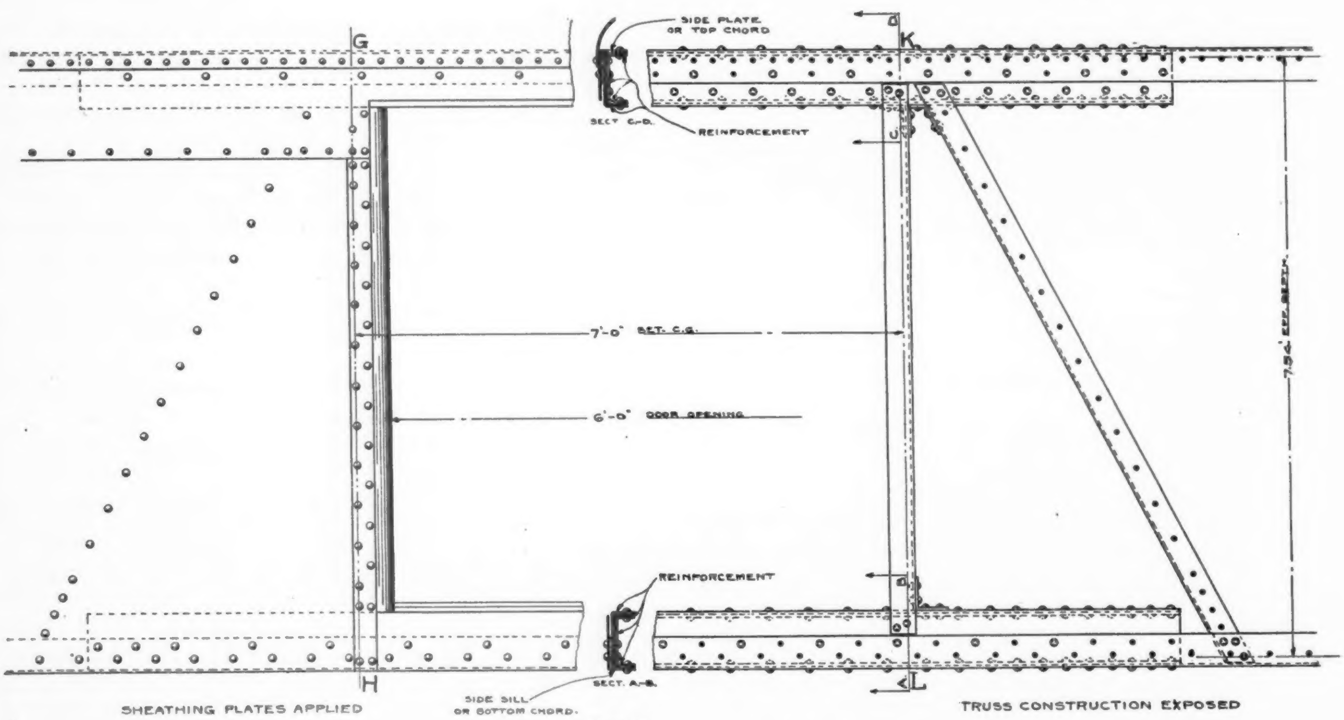


FIG. 5

and GQ, because the moments of resistance cannot be represented in a graphical diagram of this kind.

This gives a total downward force PQ = 11,750 lbs. and a total upward force QR = 250 lbs.

The arrow in the upper left hand corner of diagram, Fig. 3, indicates the direction of rotation.

Construct the diagram as in Fig. 4, scale the stresses, which will be found to agree with the analytical solution.

Also, it will be seen that the diagram closes, which, of course, checks the analysis as a whole.

It will be seen that the moment of resistance or 40,250′ lbs. will require a section of large enough area to make the 5,750 lbs. shear negligible.

Then, section A-B and C-D must have a net moment of resistance of 40,250′ lbs., and, of course, this moment must be developed in the section at G, K, H and L, or the plane of stress; therefore, reinforcement must be of sufficient length beyond G, K, H and L to anchor and develop the moment of resistance required, by the time we reach G, K, H and L.

All of which requires no demonstration here.

THIRD ANNUAL CONFERENCE OF THE APPRENTICE INSTRUCTORS

NEW YORK CENTRAL LINES.

(*Continued from the October Number, Page 389.*)

WHAT CAN WE DO TO IMPROVE THE APPRENTICESHIP SYSTEM?

H. S. Rauch.—Let us add still another subject to our courses, a subject which may be difficult to teach and delicate to handle, but which will be equally productive of results and will encourage a high standard of morals, thrift and systematic saving. No man can give to any company the best that is in him unless he is contented and happy and to accomplish this he must be frugal, of clean mind and habits, and with a knowledge of something being laid by for the proverbial "rainy day."

For the purpose of applying these thoughts and principles I would first urge the promotion of apprentice railway clubs. Get the boys interested by making the meeting place attractive, let them be governed by officers elected from their ranks, let the combined clubs of the Lines have general officers who will be kept in touch with the work of all clubs and also keep the clubs in touch with one another. The apprentice instructors should make it their duty to take a deep interest personally in all papers read before the club, making suggestions based on their more mature judgment, and above all the instructor should not forget that his example will be followed and he should take care to govern himself with this fact in mind.

We should never let an opportunity slip by in which to promote friendly relations with the boys. Our influence would be greater with a friend than with one to whom we were indifferent and we should never let our interest lag after the boy has graduated, but use all honorable means to bring out the best there is in him. We should do all we can to keep him contented so that he will remain and give us the benefit of his training.

Let us teach through papers read before our apprentice clubs that the business of no department is of such importance that it can afford to reject co-operation with other departments and that success depends upon co-operation. It is indeed a narrow-minded man who conducts an enterprise solely from the viewpoint of that particular department with which he is connected.

We must remember that the future success of this apprenticeship system depends in a large measure upon the careful selection and retention of apprentices. Those in charge of this work should make a study of human nature and aim to place a boy in that vocation to which he may be particularly adapted. We should then watch him and if a mistake has been made, if nature has not fitted him for the work he is doing, the remedy should be an early transfer to a more congenial occupation.

TO IMPRESS THE APPRENTICE WITH THE VALUE OF AN EDUCATION.

C. A. Towsley.—While the future career of an apprentice depends to a large extent upon himself, his possibilities are dependent to no small degree upon the influence of the instructors and it is our duty to see that the boys are continually made aware of the benefits resulting from constant application to their work and the solution of every problem that may come up in the regular routine of the shop and school.

The average apprentice is inclined to look upon the routine work as drudgery that should be passed over with as little effort as possible, little realizing that each operation is a stepping stone that is to gradually build the foundation upon which rests his future success. We should try to formulate some line of action that will appeal to them and awaken a realization of the benefits that may be derived from a close application to their various duties. We should stimulate a constant alertness for all of the little things which are usually passed by unnoticed and appear too trivial to be grasped and mastered and made available for future needs.

Many apprentices are prevented from advancing on account of timidity and fear of placing themselves in a position which might incur the jeers and taunts of their companions. If an apprentice is noticed by his fellow workmen to be more intent upon his work than usual, or working a few moments after the whistle blows, he is immediately set down by a certain class as a pet of the boss and it is noised about that he is working for a "stand in." Many boys through a foolish sensitiveness avoid doing any work that is commended by the foreman, or noticed by the management. If we can remedy this, if only to a small extent, we will have removed one of the worst stumbling blocks from their path.

A great many boys delude themselves with the idea that when the opportunity comes they can jump into a high place and swing it to perfection; that all it takes to reach the goal of their ambition is nerve. We should call our boys' attention to the fact that they must work their way up and expect everybody else who may be striving for the same position to pitch in and try to hold them down; that our industries and institutions would collapse if undeveloped, untried men were to lead them. We should teach them that success comes only through hard knocks and perseverance.

CO-OPERATION—HOW TAUGHT.

V. J. Burry.—The old apprenticeship system lacked the spirit of co-operation. Before we had a shop instructor if the apprentice, when placed on a machine, asked a mechanic how to do a certain job he would get the reply: "You will have to learn that in the same way that I did." And if the boy went to the foreman for the information he would usually find him so loaded with other duties that he would not have any time to devote to apprentice education. The result was that the machine did not turn out the work and the boy finally became disgusted with his trade. With a shop instructor the apprentices are thorougly instructed in the work on the different machines; this not only encourages them, but increases the amount and quality of the output.

In the classroom we have problems showing the boys how to cut plates so as not to waste the material, thus teaching them economy, the knowledge of which will save the company much in dollars and cents in the future. Since we now have courses in nearly all trades the bright, wide-awake apprentice boy who has finished the drawing and problem work in his own trade may take up that of another department, thereby widening his field of usefulness and broadening his ideas so that he will be in sympathy with all his fellow workmen.

Apprentice clubs and ball teams teach co-operation. Without team work the nine could not win; they must all play together for a common end. The debating club promotes good friend-

* The proceedings of the first annual conference will be found in the November, 1907, issue of this journal, and those for the second annual meeting in the October, 1908, issue. The organization of the apprentice department and the methods and equipment used by it were described in detail in the June, July, September and October numbers, 1907.

ship and the different subjects discussed awaken interest along new lines.

Co-operation and system eliminate friction and bad feeling. Among the apprentices every boy has an equal chance to make good and there can now be none of that jealousy which formerly existed when sons of employees and special apprentices were given every opportunity to advance and other boys were not noticed.

In conclusion I will repeat the first paragraph of the open letter written to all departments by President W. C. Brown. *"Co-operation between every department of this system is essential to its success. This means not only sincere, heart-felt interest in the welfare of the system as a whole, but personal friendship for the officers and employees of other departments, and an eagerness to assist all departments, so far as possible, in order that the best results for the entire system may be accomplished."*

AMOUNT OF HOME WORK.

A. L. Devine.—I believe it would be advisable to give each apprentice a month's supply of home problems at one time and the number of sheets given out should be determined by the number of class days for each month. If there are eight sessions for a certain month the boy should be furnished with eight problem sheets* at the first class he attends for the month in question, with the understanding that the entire lot must be worked out and returned correct before the first class of the following month. It should be optional with the boy whether he hand in all at one time or one at each class meeting. If a boy hands in the entire lot at the class following their receipt, it should be understood that no more sheets will be furnished him that month unless he requests them. This, of course, excludes all problem sheets returned for correction. We have tried this arrangement during the past two months with sixteen new apprentices and must admit that the results obtained far exceeded our expectations. Not one of these boys failed to live up to the requirements; on the contrary, four boys requested additional sheets before the end of the month and all expressed their approval of this innovation. This system reduces the clerical work in connection with the problem record sheet.

H. S. Rauch.—The number of problem sheets to be issued at one time depends largely upon the apprentice to whom they are issued; some boys do six or eight in a month while others will be able to do but three or four. One month's supply of problems is a sufficient amount to be given out at one time. We should require not less than three home problem sheets per month from each boy and care should be exercised not to let the boys know what the minimum is as we should require more than three sheets from those who are capable of doing it. My practice is to give each apprentice on the first of each month an amount of work which in my opinion is a reasonable requirement for that particular boy. I would then insist that he have this work all in and correct by the last day of the month for which it was issued. In this way I have been reasonably successful in getting my boys to do the home problem work.

B. Frey.—I think better results can be obtained by handing out ten sheets at a time than by handing out only four as called for by the spaces on the problem record sheet. In most cases it is harder for a boy to get started to work on the problems than it is to keep going after once making a beginning, and therefore if he had a larger number of problem sheets he would oftimes work out six or more at one time, instead of only one or two as at present. It is, of course, not necessary for him to hand in all of the sheets at once. The reason for suggesting ten problem sheets is that the record of problems given out can be more easily followed. Issuing sheets from 1 to 10, 11 to 20, 21 to 30, etc., affords a better means of determining just how many the boy has at home by simply looking at the last sheet handed in. This makes it easy to find out when the boy should be given a new set of problems without having to look at the problem record sheet.

* Each problem sheet contains a number of problems.

As to the minimum number of home problem sheets which should be required each month, I believe at least one sheet should be handed in each week. This will be necessary in order to properly get through the courses for each trade as outlined.

PENALTIES FOR FAILURE TO DO HOME OR CLASSROOM WORK.

A. L. Devine.—We have no arrangement for imposing a penalty for failure to do home work other than notifying the general foreman resulting in the boy's receiving a mild "call down" from that officer. I would offer the suggestion that where boys fail to hand in the required number of problem sheets per month, that the delinquents be requested to report to the general foreman in a body. This could be handled very nicely by having them assemble in the classroom directly after lunch on or about the first day of each month. A boy reporting to the general foreman the second time for failure to do the required amount of work should be just cause for suspension, and the third time dismissal. If this rule was rigidly enforced and an example made of a few boys I believe we would have very little trouble from this source.

The time has certainly arrived when the instructor should have the encouragement and support of the local officers concerning this matter and the instructor's suggestions should be carried out in each case so that discipline can be maintained. I believe it would be unnecessary to provide a penalty for failure to do classroom work providing the problem sheets were distributed as soon as possible after the class opened. This would allow sufficient time to do all problems; if not, the sheets could be collected and returned to the apprentices at the next meeting of the class.

H. S. Rauch.—The penalty for refusing to do home problems should be dismissal. Inability to do this work, however, should be treated with the greatest consideration and every effort should be made to instruct the delinquent. Failure to do classroom problems should be dealt with on the same basis as home problems. If a boy is lazy and refuses to get into the game, and if reasonable methods prove futile, I would say send him to the employing officer with a request for his dismissal. But the instructor must use good judgment and not give the boy a greater amount of work than he is capable of doing, making the mistake of thinking him lazy because he does not keep up.

B. Frey.—We seldom have occasion to resort to penalties for failure to do home or classroom problems, as the apprentice usually understands that there is a fixed number of problems which must be handed in each month. If he falls a little behind one month, he is asked to hand in his back problems during the first two weeks of the following month. If he does not hand them in then, and has no good excuse, we resort to some sort of penalty, such as sending him back to work in the shop, which obliges him to explain to his foreman why he is not in the school.

A boy should not be reported to the foreman unless absolutely necessary. In an extreme case more stringent means may be used. For instance, an apprentice was sent home for not handing in the required number of home problems and was instructed that if he did not appear in the morning with them all worked, he would be discharged indefinitely. The result was satisfactory and we have had no other occasion to resort to such methods. Many penalties and methods of stimulating apprentices to do their best may be used, but I believe a systematic arrangement of the work will do more good than any punishment or other form of stimulation.

STIMULATING INTEREST IN CLASSROOM WORK.

V. J. Burry.—First of all, we must know our boys, and must not forget that we are teaching boys. How can we know our boys? By honestly wanting to know them, by wanting to know them so much that we are willing to let our theories about them be destroyed and willing to give time at a sacrifice to get acquainted with them.

In the classroom laboratory we have the small engine, the lathe, the gear rack, the valve gear model, and many other sim-

ple models and devices, and by touching on their different mechanical points, we arouse the boys' curiosity, and curiosity is, broadly speaking, desire to know. We are familiar with its various forms and we all possess it to a greater or lesser degree. It acts as an appetite to the mind and is natural to a boy. It is an open door to the realm of knowledge, and an instructor should use it as a valuable aid in gaining interest, and interest does not mean to amuse, to entertain, but to arouse activity in a boy and make his mind work.

It is all very well to have books of mathematics and mechanics—we cannot get along without them—but seeing is believing, and the real way to stimulate knowledge is to show the boy the actual mechanism which illustrates the mechanical principle which we wish to teach him. We cannot expect the average boy to be interested in a problem or machine requiring much thought unless we are interested in it also. The boy gets inspiration and enthusiasm from the instructor, who should explain the problem or principle in a simple, conscientious way, repeating over and over again, if necessary, each step and always displaying that interest which is the secret of successful teaching.

A whole paper might be written about the moral side of apprentice instruction, gaining the confidence of the boy, knowing him at home and outside of working hours, and building up his character at the same time that we are building up his brain power and efficiency. All of this must be accomplished if the best that is in the boy is to be developed. Teaching is hard work and the love of it and the knowledge of the good we are doing is our stimulant. The pay is small in actual dollars, but the greatest reward is in our consciousness of the value we are, not only to the railroad company, but to the community. Our aim should be to train the boys in good citizenship, and raise the standard of honest and right living.

DISCIPLINE IN THE CLASSROOM.

Mr. Kuch, Sr., directed attention to the importance of exercising the same discipline in the apprentice schoolroom as is used in the classrooms of our schools and colleges. Promptness, neatness, cleanliness, obedience, politeness and strict attention to the work should be insisted upon.

drawing suitable for use in the erecting shop. After tracing the pencil drawing each boy, wherever possible, is allowed to take a blueprint of the tracing himself and this he may keep as his own.

TEACHING OF SPELLING AND LETTER WRITING.

Mr. Kuch, Sr., outlined an exercise in spelling such as is used at Depew, the object being to familiarize the boys with the correct or standard names for the different parts of locomotives, cars, etc., as well as the correct way in which to spell them. After the words have been given out and the papers collected different boys are sent to the board and asked to explain the different parts by sketch.

Letter writing is also taught in a very practical manner at Depew. No material is issued to boys in the drawing room unless the request is properly presented in writing in the form of a letter. In addition to this they are occasionally asked in class to write short letters in connection with their shop work. These are collected, corrected and returned at the next exercise.

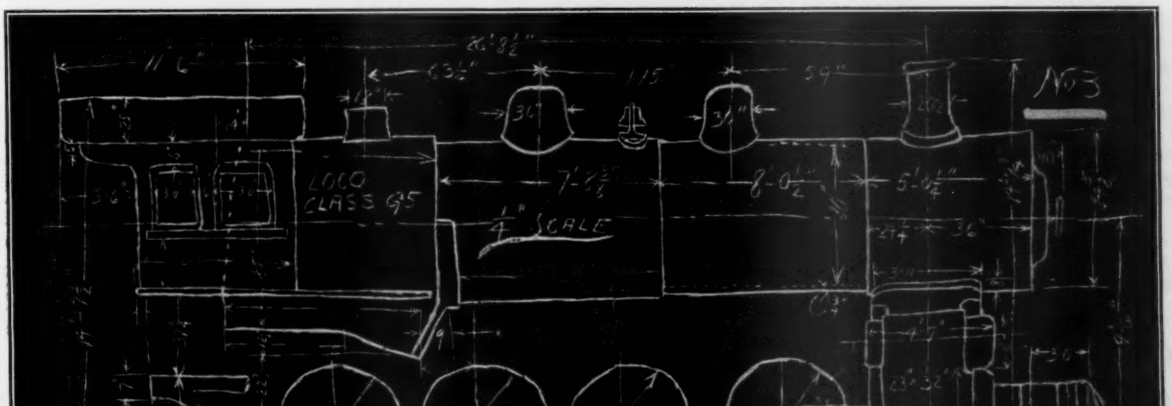
Discussion.—After a thorough discussion it was decided to adopt Mr. Kuch's suggestions and put them into practice at all the schools.

CLASSROOM AND LABORATORY WORK.

H. S. Rauch.—Our practice at Oswego is to devote one hour and thirty minutes to drawing and thirty minutes to blackboard and laboratory work each day; this we find very satisfactory. For machinist apprentices I would recommend the following courses in blackboard and laboratory work in the order given.

1—Blackboard problems.
2—Gearing problems, including thread cutting on laboratory lathe using wooden mandrel and lead pencil.
3—Course in laying-out for drilling, slotting, boring, etc., using wooden models.
4—Lever problems with beam and weights.
5—Valve problems and valve setting on classroom engine.
6—Blue print reading.
7—Steam gage problems.
8—Course on strength of materials.

If these courses are followed up gradually, taking each part in detail, the apprentice will soon master the principles involved. This schedule will have to be varied somewhat for the other



AN INTERESTING DRAWING EXERCISE.

AN INTERESTING DRAWING EXERCISE.

At some of the schools advanced boys are given the outlines of an entire locomotive and tender to draw to scale and trace. The photo shows an engine drawn upon the blackboard, which is to be copied by the apprentice on drawing paper.

This work is stimulating and instructive—what boy, mechanically inclined, does not look with pride upon his first crude drawing of a locomotive. These boys go farther and make a

trades, cutting out valve setting and thread cutting and substituting courses applicable to the trade the boy is learning. Each of the courses, as listed above, should be so arranged that an average boy could cover the whole in four years, or in other words, no course should consume so much time that others would have to be omitted.

Once each month I would suggest suspending all work in the classroom and laboratory and giving the whole class a talk on

some general subject of interest; taking up the air brake first, using charts and sectional models when available, or if charts cannot be procured a diagram on the blackboard answers very nicely.

Discussion.—Where the classes are large it is the practice to have a few boys work at a time on the special problems in laboratory work. By devoting the entire period of two hours to it, or as much time as is necessary, they can complete the experiments and do not need to overhaul and rearrange the apparatus again, as they would if they were allowed shorter periods in which they could not complete many of the experiments.

WALSCHAERT VALVE GEAR—CLASSROOM INSTRUCTION.

A. W. Martin.—We have in the classroom at Beech Grove a wooden model of the Walschaert valve gear on our standard G-5 H A engines, made ¼ size and mounted on a pine board 72"x36"x1". This model was made by the patternmaker apprentice boys during their regular school hours and they did a job that would be creditable to any mechanic. The model is of value to machinists as well as apprentices. Men from the shop come to the school during the noon hour and study the motion by assuming certain conditions and then running the model over to get the different valve events. This interests the boys and they are all anxious to do the problems.

To start a boy on this work, we give all the adjustable parts, such as the valve, eccentric crank and eccentric rod, an improper setting. He is then given a set of instructions and told to square the valve, giving it equal lead in both forward and backing motions when the engine is on both centers. After doing this he is given a standard valve measurement sheet and required to fill in all the valve events at four positions of the gear. These valve events are preadmission, lead, port opening, cut-off, release and compression. Having gone through this work he is ready for the motion gang and should need very little shop instruction in order to do any work he may be given. If the model is carefully built a very close adjustment can be made which need not exceed a maximum variation of 1/64-inch for the four lead events.

Instructions for Adjusting Walschaert Valve Gear.

(These instructions apply to the piston valve engine with inside admission, and combination lever fulcrum located above the valve stem; the link block is below the center of the link in the forward motion.)

Assuming all parts of the valve gear to be correctly proportioned we may proceed as follows:

1. With port lines marked on valve stem and main rod, valve and all parts of the valve gear connected, excepting the link end of the eccentric rod, adjust the link block so that there will be no movement of the valve when the link is oscillated on its center. In case both valves do not remain stationary with one position of the reverse lever, adjustment must be made in the lifting device of either side until they do.

2. With reverse lever in its central position, as found above, we next connect the link end of eccentric rod and find both dead centers of engine and with tram mark same on wheel from any rigid point; also mark the extreme travel points on the guides, at the same time checking the port lines for equal lead; square lead by adjusting valve stem as per Case 1 following.

3. With valves approximately set and ready to run over in order to get the different valve events, place engine in the forward motion and catch the front and back centers, at the same time noting the position of the port lines as in Case 1. Repeat this operation with engine in backward motion. With position of port marks noted, we may have readings similar to either of the four cases following. After adjustments are made the valves should be run over in their principal positions. Valves may be considered as practically correct when the cut off and release events in the forward motion, at the usual running position (say 25% cut off) do not vary over 1/32 of an inch, though of course closer adjustment is desired when possible.

Rules for Making Adjustments on the Model.

1. The eccentric crank is correctly set when the sum of the leads in forward and backward motion are equal. Thus in Fig. 1 A + B = C + D.

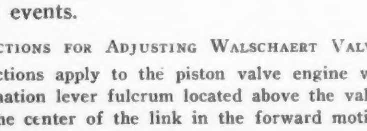


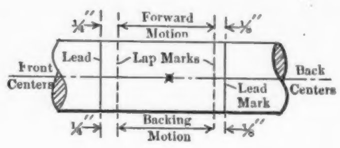
Fig.1

2. Shortening the eccentric rod increases the lead at points C and B and decreases the lead at points A and D (Fig. 1), and vice versa. This may be done by means of liners in the strap end of the rod.

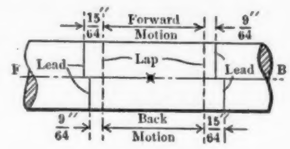
3. Decreasing the throw of the eccentric crank decreases the leads in forward motion and increases the leads in the backward motion, and vice versa.

Following Are Four Cases of Valve Port Readings.

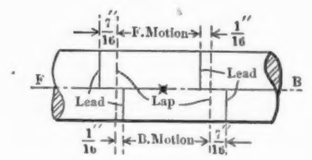
Case 1. When the two leads on the front centers in both motions, and the two leads on the back centers in both motions, are equal; but the front center leads not equal to the back center leads, as shown in the



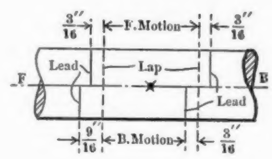
Case 1



Case 2



Case 3



Case 4

figure, we must make them all equal as follows: Adjust the valve stem an amount equal to ¼ the difference of the sums of the leads in both motions, thus:

$$\frac{\left(\frac{1}{4}+\frac{1}{4}\right)-\left(\frac{1}{8}+\frac{1}{8}\right)}{4}=\frac{1''}{16}$$

In this case the valve stem should be adjusted 1/16" to the right. This shows, according to Rule 1, that the eccentric crank is set correctly.

Case 2. When the leads come as shown, that is, the forward motion lead on the front centers is equal to the back motion lead on the back centers and the forward motion lead on the back centers equal to the back motion lead on the front centers, they must all be made equal by shortening the eccentric rod an amount equal to ¾ the difference of the sums of the leads, thus:

$$3\left[\frac{\left(\frac{15}{64}+\frac{15}{64}\right)-\left(\frac{9}{64}+\frac{9}{64}\right)}{4}\right]=\frac{9''}{64}.$$

When this is done we will have equal leads in both motions.

Case 3. Here we have 1/16" negative and 7/16" positive lead in both motions. In this case the valve may be squared by shortening the eccentric rod an amount equal to ¾ the total sum of the positive and negative leads, thus:

$$\left(\frac{7}{16}+\frac{7}{16}+\frac{1}{16}+\frac{1}{16}\right)\frac{3}{4}=\frac{3''}{4}.$$

If the leads came just the reverse of the above we would have to lengthen the eccentric rod to equalize them. (See Rule 2.)

Case 4. The figure shows 3/16" positive lead on both centers in the forward motion and 9/16" positive lead in the back motion on the front center, and 3/16" negative lead in the back motion on the back center. First move the valve stem 3/16" toward the back center. The next step is to equalize the lead as in Case 2. This may be done by lengthening the eccentric rod. (See Rule 2.)

DRAWING COURSE FOR BOILERMAKER APPRENTICES.

[*Editor's Note.—The general drawing course of* 65 *sheets is followed by all apprentices; after completing these each trade has a course of its own.*]

A. W. Martin.—In order that an apprentice may become a first-class boilermaker and layer out he must be able to read and make a working drawing. To lay out a pattern it is not necessary to make a blue-print or scale drawing. A pencil sketch giving the principal dimensions is sufficient for drawing the elementary lines that are necessary for the development.

Every boilermaker apprentice should upon starting his apprenticeship be given the lessons in the new general drawing course. He should then take up sketching and the making of working drawings of all parts of the locomotive boiler, starting with simple details such as staybolts and stayrods and gradually advancing until he is able to sketch and draw the entire boiler. The average apprentice could accomplish this in from twelve to eighteen months, and would then have acquired the general principles of drawing as well as a thorough knowledge of boiler details and construction. This knowledge will not only be a great benefit to him in his daily work in the shop, but will prepare him for the sheet metal drawing course which should follow. This

course starts in with the development of patterns for simple objects, such as square and round pipes, etc., gradually leading up to the more difficult jobs.

The three methods in general use for developing patterns should be taught the boys; these are, by radial lines, parallel lines and by triangulation. When the principles of these three methods are clearly understood a boy should have no trouble in developing the surface of any object. It has been two years since the boys in our shop started on the sheet metal course and our foreman boilermaker takes considerable pride in telling of some of the work that they have done.

We have found it good practice to have wooden models made for all the objects in the drawing course which are to be developed. The patterns may then be cut out and fitted on the models to prove that the work is correct. Some of the wooden models at Beech Grove are as follows: Square and round pipe, irregular and regular tapering pipe, Y branch pipe, transition pipe with rectangular to round opening as used over forge fires, etc. We have, also, a small model firebox of our K-2 engines that the boys use for trying on paper patterns of one-piece wrapper sheets that they have layed out. All these models are made one-quarter size.

We have under construction a one-quarter size class C boiler model to be made of No. 18 planished copper. All the patterns for this have been developed and the work of constructing the model is being done by the boys during their regular school hours. Since the use of models has been adopted the boys have been greatly stimulated in this work. They can try their patterns on the models and see how true are the principles which they have learned and applied when drawing and developing them.

It would be well to use part of the tinsmith course for the boilermakers as the early stages of development and laying out of patterns are practically the same for both.

C. P. Wilkinson.—Detailed sheets should be made of all plates in the various types of boilers, and showing all the lines necessary for their development and containing a full explanation with all necessary instructions. For example, the combining of the firebox side and crown sheets in one plate is a recent design, and for those not familiar with the work of laying out such sheets, there is much chance for error. A lesson sheet showing the details of how to lay out this plate would be beneficial.

It is not to be expected that many boys will care to put in the time and study necessary to make them experts, but there will be enough who will, if properly encouraged by the instructors. We should have as many models as possible made to a size as large as practical to test the accuracy of the drawing work after the patterns have been developed and cut out of brown paper or cardboard. While the tinsmith's course does not apply directly to boiler work, yet it contains problems that every sheet iron worker should know, and it should, therefore, be included in the boilermaker's course.

A SIMPLE TESTING MACHINE FOR STUDYING THE STRENGTH OF MATERIALS.

H. S. Rauch.—The machine is constructed with four 1½-inch round posts, 30 inches long, connecting top and bottom plates, 1 inch thick and 12 inches square. From the center of the upper plate is hung the lever arm to which the upper end of the test piece is attached. The load is obtained through two 1½-inch square thread screws working in a threaded yoke. This yoke grips the lower end of the test piece. The lever arm is 4 feet 0 inches long, giving the machine a capacity of about 5000 pounds when using a 60-pound weight. This machine was designed for testing the tensile strength of ¼-inch round or square specimens. It can also be used for finding the compressive or shearing strength of specimens by means of an auxiliary yoke and plate extending from the lever arm or upper connection down to the under side of the threaded yoke. The piece to be tested is then placed between this plate and the threaded yoke. Turning up on the two large screws will put the test piece in compression.

In outlining a course of study on the strength of materials care should be exercised not to get the course too technical, and in the selection of terms and names which might confuse or discourage the average apprentice.

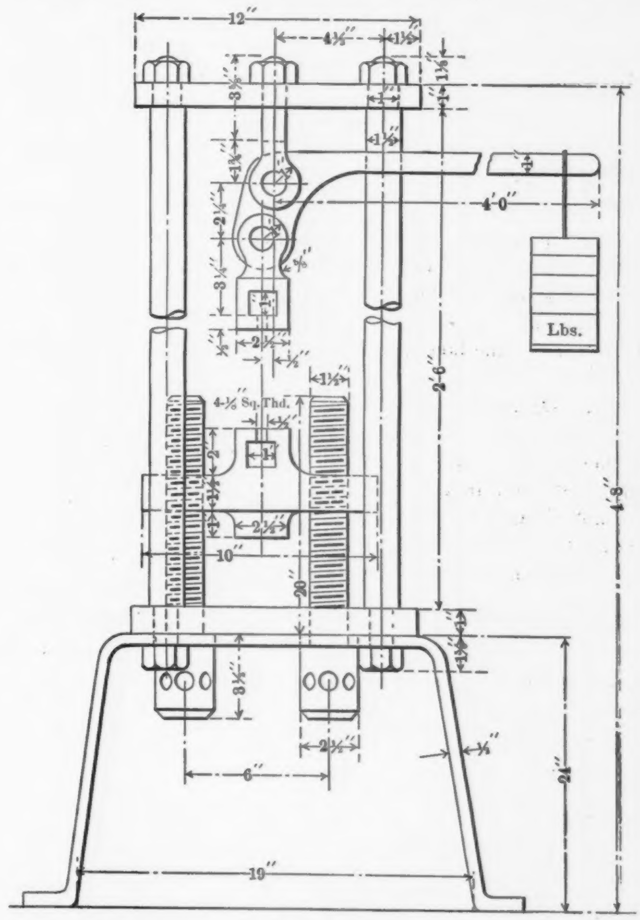
It is suggested that the first sheets of the course be instruction sheets as follows: Materials used for construction, giving a list of those in most common use and with a short description of the composition of each. Short definitions of live and dead loads, stresses, tension and compression, shearing, elastic limit, working strength, ultimate strength, etc. Simple rules for finding the above should be given as needed.

Take up next the study of stresses and strains, using the results obtained from actual tests of specimens. The following problems will illustrate this:

No. 1. What size bar would be required to raise 5 tons in a straight lift, allowing a factor of safety of 5?

No. 2. How may ¾" wrought iron studs would be required to hold a cylinder head having an area of 196 sq. in. with a mean effective pressure on the cylinder of 160 lbs.? Allow a factor of safety of 10.

A number of problems could be arranged for each material tested, each problem to illustrate in what practical way the material is used. For example, in testing staybolt iron all problems



MACHINE FOR STUDYING STRENGTH OF MATERIALS.

should deal with staying different parts of a boiler at different pressures and using different sizes of bolts.

After having gone through the list of materials usually subjected to a tensile stress, take up compression, treating it in a similar manner. It is important that in each case all problems should refer to practice with which the boy is familiar from his work in the shop. This may be illustrated by the following example:

No. 1. How much would a piece of steel used for pressing out crank pins be shortened if it is 4 in. in diameter and 10 in. long? The total pressure used was 100,000 lbs.

The next in order would be shearing stress; treating this in the same manner as tension and compression and always taking care to have the problems so closely related to the boys' work that the benefit to be derived will be easily recognized.

It is also suggested that tests be made on cement. Test pieces should be constructed by the boys in the laboratory and an accurate record kept of the quantities of the different materials.

used in their composition. The age of the test piece, effect of hardening under water, etc., should also be recorded.

To conclude the course about ten sheets of problems should be devoted to a general review working in the principles previously learned. In all the work it would be profitable to make blanks for recording the history and performance of each specimen, stating whether it is from new or second-hand material, to what specifications ordered, etc. From the information obtained through actual tests a set of tables should be made in data sheet form (these could be traced and printed by apprentices) giving the strength of different materials, under different loads and stresses. These sheets should be retained by the apprentices for future reference while working in the laboratory, and after graduation they would make a valuable addition to the boys' stock of useful information.

I believe the courses as outlined, properly worked out in detail and given to apprentices in all trades during the last year of the apprenticeship, would insure a more intelligent knowledge of the materials with which they work and a better idea of design and construction than could be obtained in any other way.

Discussion.—Mr. Rauch was asked to develop this course and report results later.

NUMBER OF DRAWING EXERCISES TO ISSUE AT ONE TIME.

H. S. Rauch.—The drawing lesson sheets should be issued in lots of 25, neatly bound together with brass fasteners.

B. Frey.—I believe that giving the boy a booklet containing 8 sheets is proper since it gives him an opportunity to look ahead and become familiar with the next lesson while he may be waiting for assistance. These sub-divisions form a sort of goal to work for and have a tendency to stimulate the boy to get into the same book as his neighbor who may be a little ahead of him.

A. L. Devine.—I would suggest that they be put up in book form, 23 sheets in a book, and with a standard print cover and cardboard back. We have tried this with the new general drawing sheets and found it to work very satisfactorily. The boys are not allowed to take up their drawing sheet or proceed with the next drawing until the instructor checks the work and marks his initials on the title space of the sheet.

SHOP COURSE FOR SPRING MAKERS' APPRENTICES.

H. J. Cooley suggested the following four-year course for spring makers' apprentices. He was asked to give it a trial and make a report later.

Helping	0 to 2 months.
Shearing	3 to 4 "
Nibbing	3 to 4 "
Rolling	4 to 6 "
Punching	4 to 6 "
Heating	5 to 6 "
Tempering	5 to 6 "
Bending	3 to 4 "
Testing	3 to 4 "

This allows 6 months which may be used as the foreman thinks best in order to build up any branch of the work in which the boy may have shown a weakness.

DUTIES OF THE SHOP INSTRUCTOR.

W. F. Black.—One of the first duties of a shop instructor is to create a feeling of friendship and trust, not only with the apprentices, but with the mechanics and shop foremen with whom he comes in contact. He should always strive to obtain the best results from the apprentices and for the company, and to do this he must be with the boys at all times. When a boy meets with a difficult job stay with him until he understands it thoroughly; oftentimes you can tell a boy how to go ahead and do it, but when you leave him to his own resources he is doubtful how to start the work and will lose time.

When in the shop I have often been asked this question, "How do you get so dirty?" and my answer is this: When a boy is working in the front end of a boiler or underneath an engine it is the shop instructor's duty to be with him and see that he is doing his work properly. If he needs instruction do not neglect him just because he is in a difficult and dirty place.

It seems to me it should be the duty of the shop instructor to spend one hour at each session in the classroom and laboratory and to keep in close touch with the apprentices in the drawing and problem work, assisting the drawing instructor to the best of his ability.

In regard to the shop instructor supervising apprentices in other trades with which he may not be familiar, would suggest that he use all means to gain the confidence and respect of the foremen and show them that his interest in their boys is bound to work to their advantage. Instruction given boys by the foremen is of great value and in some trades the foreman must be depended upon to give practically all the shop instruction which the boy receives. The shop instructor, if he is a graduate machinist, could only occupy a supervisory position in the smith or boiler shop. He should visit these shops once or twice a day and see that the boys are faithful in their work.

SHOULD THE SHOP INSTRUCTOR NOTIFY THE FOREMAN OF THE BOY'S NEXT ADVANCE IN RATE?

M. T. Nichols.—I do not think it necessary for the shop instructor to notify the foreman directly of the apprentice's increase in rate. This should come from the shop superintendent's office. We are using the following method which covers the ground very satisfactorily. On the last day of the month I send a list of all the apprentices to the time-keeper, asking him to advise the number of days each apprentice worked during the month. I then add the days he gives me to the number of days credited in the record and whenever an apprentice is to receive an increase during the next month I send a notice to the assistant master mechanic which he forwards to the time-keeper.

G. Kuch, Jr.—It would be well to notify the general foreman when the time comes due for the boys' next advance in rate. The shop record shows the number of days credited for the month and the total days since beginning their apprenticeship; this will give the date of the boys' next advance in rate very closely.

R. M. Brown.—Most of you know that on the Lake Shore, we keep an efficiency record card* of all employees, including the apprentices. The clerk in the office of the superintendent of shops keeps the apprentices' time, which is furnished to him by the shop accountant. When a raise in rate comes due, the clerk and the shop instructor get together and notify the superintendent of shops of such boys as are due for a raise. They make up a regular form to be approved by the superintendent of shops and the superintendent of motive power, which finally comes back to the shop accountant. Before raising their rates we look up their efficiency record to see if they show up well. If they do not my attention is called to it and we find out why the boy hasn't a good grade.

Discussion.—It developed that the practice outlined by the first two speakers is in use at practically all of the shops.

SHIFTING APPRENTICES.

M. T. Nichols.—We are trying a new method of shifting apprentices at the Elkhart shops which we feel sure is going to prove successful. It seems wise to keep a boy on some jobs longer than on others in order that he may become thoroughly familiar with the work, and for this reason we have decided to lengthen the time for all jobs from three to four months, but at the same time following as closely as possible the N. Y. C. Lines standard schedule.

The sequence or order of shifts sometimes makes a difference in the length of time a boy is left on a job before being shifted and a great deal also depends upon the boy's natural mechanical ability to learn quickly. A boy who has learned to run a planer will need but a short time to learn to run a shaper, and if he is put on the shaper right after the planer he may not need to remain there as long as if he had come from a lathe.

G. Kuch, Jr.—The shop instructor should carefully study the

* See December, 1908, issue of this journal, pages 459, 460 and 468.

shop record of apprentices near the last of the month and note any boys who have been on the same class of work for three or four months. He should then make a list of these boys, giving them shifts which will make their work most advantageous to the company and still as far as possible in accordance with the New York Central Lines schedule of courses. The instructor should show this "line-up" to the foreman for his approval. The list should be made a week or so ahead of the first day of the month so as not to delay the work when the shifts are made.

I would recommend that the boys be shifted in groups of from three to seven at a time, since by so doing they can be better handled and instructed in the work. When making shifts of groups of boys care must be taken not to have all of the boys from one department attend the same class in the schoolroom, since the department would be weakened by so many boys leaving it at one time.

The shop record and monthly report should be kept by the shop instructor as these two reports are the whole key to the apprentices' changes and without this record it would be impossible to check the time the boy is on a certain class of work. When the shop instructor keeps this record he can see the boys' marks relative to workmanship and personality and can in many cases shift a boy to that class of work to which he may be best adapted. By keeping in close touch with these records the shop instructor can see the total days credited on the record for each boy and how he is getting along in his time so that the proper shifts may be made as per schedule.

Discussion.—At Jackson all of the boys are shifted at the same time—the system of gang bosses is such that this may be done without disorganizing the work.

OBSERVATION TRIPS FOR INSTRUCTORS.

C. A. Towsley.—We should be on hand before the school we visit is called to order to note the deportment of the boys in getting their outfits and taking their places. Make it a point to look over their work carefully and make mental comparisons with the work of your own boys and decide whether you are holding up your end. Look over all of the apparatus with a view of improving your own on your return. Whenever anything of interest is found, make a note and, if necessary, a sketch of it, to insure against the loss of any valuable information. A walk through the shops will be a fruitful source of information about many little kinks and tools that will undoubtedly be acceptable to your superiors upon your return.

There is nothing better for the general advancement of the instructor than a visit to one or more of the schools and shops. It works up a new store of enthusiasm—you feel that you are more than ever a factor in the great educational system and you go home more satisfied and better qualified to meet the emergencies that come up from day to day.

TOPICAL DISCUSSIONS.

Classroom Instruction in Shop Practice.—It was decided to have the shop instructors look into the advisability of arranging a course of instruction on the proper names for tools, the best shapes for different purposes, proper ways of setting, the handling of special jobs, etc.

How Far Should Instruction in Algebra, Geometry and Drawing Be Given?—The sentiment seemed to be that only the simpler principles of algebra and geometry should be considered—just enough to solve the ordinary shop problems and make the principles of mechanical drawing clear. As a matter of fact the algebra and geometry that is taught is not designated as such, but the principles are introduced from time to time as they are needed in the problem course. The amount of mechanical drawing depends on the trade.

The Assistant Classroom Instructor.—At West Albany there are two assistant classroom instructors, one for blackboard and laboratory work and one for problem work. At Collinwood there are two assistants for each class, or six in all. These boys are shifted every three months. In the absence of the instructor they conduct the school.

Should the Boys Be Discouraged from Becoming Draftsmen?—Mr. Martin, of the Beech Grove shops, said: "During the past two years, among all the boys who have completed their apprenticeship courses, we have only had one who expressed a desire to become a draughtsman. He was out of his time two months ago and left the service. He was also the only boy to leave the service after completing the course. We have turned out many boys who would make very good men in the drawing room, but they all preferred to stay in the shop."

On the P. & L. E. R. R. the drafting room force for the past two or three years has been recruited from among the graduate apprentices. If a boy has a strongly developed tendency toward drafting room work he should not be discouraged from following it up.

Should There Be a Separate Shop Instructor for Car Shop Apprentices?—Mr. Cooley said that they had twenty-four car shop apprentices at Collinwood. The duty of seeing that they are properly instructed is alloted to the assistant foremen in the various departments. The only place where they feel they need a special instructor is in the freight car repair yard, where they have nine apprentices.

Course in Lettering for Painter Apprentices.—The discussion indicated that there is a need for such a course to be taken at the conclusion of the general drawing course.

Difficulty in Obtaining Boilermaker and Blacksmith Apprentices.—It has been overcome in some shops by increasing the rate. The instructors should secure the co-operation of the foremen in making conditions more attractive.

Use of Stools in Drawing Room.—It was the opinion of all that the drawing room should be so provided and that better work was done when the boys could either sit down or stand at their convenience.

Should Square Root Be Taught?—Mr. Towsley, of Elkhart, said: "We have been teaching it for about six months, and all of the boys with but a very few exceptions are now quite familiar with it and can use it whenever occasion requires. A number of the problems in arithmetic required its use, and rather than beat about the bush with approximations, we decided it would be better to give all an insight into the method of using it. We give all members of the class twenty minutes of arithmetic at the blackboard at the close of every session, and we devoted this entire time for several weeks to the study of square root and general problems requiring its use. From the results we feel that all are amply repaid for the time thus spent, and can heartily recommend its adoption and addition to the regular course." Mr. Gardner stated that a course in square root was in preparation.

Travel Becoming Safer.—During the fiscal year that came to an end on June 30 last, the Chicago and Northwestern road carried a total of 27,000,000 people without a single fatality. This is the first road reporting such a remarkable record for the current fiscal year. Two roads, the Pennsylvania and the Burlington, accomplished a similar feat for the calendar year of 1908. The three records are taken by railway experts to indicate clearly that the science of railroad operation has made a substantial advance during the past two or three years. Better discipline has been inaugurated, block signal systems have been extended and, in the case of the Northwestern, double tracks have been completed between Chicago and the Missouri River.—*Railway World.*

Surprise Tests.—Over 156,000 efficiency tests were made by the Pennsylvania Railroad in the first six months of this year, and practically a perfect record was made by the employees. The average number of tests made each day was 862, and of the total for the six months, 99.6 per cent. were perfect. In the .4 per cent. of failures are included the cases where enginemen passed signals by a few feet before stopping their trains, and similar cases which, though technical violations, were not such as would make possible an accident to a train.